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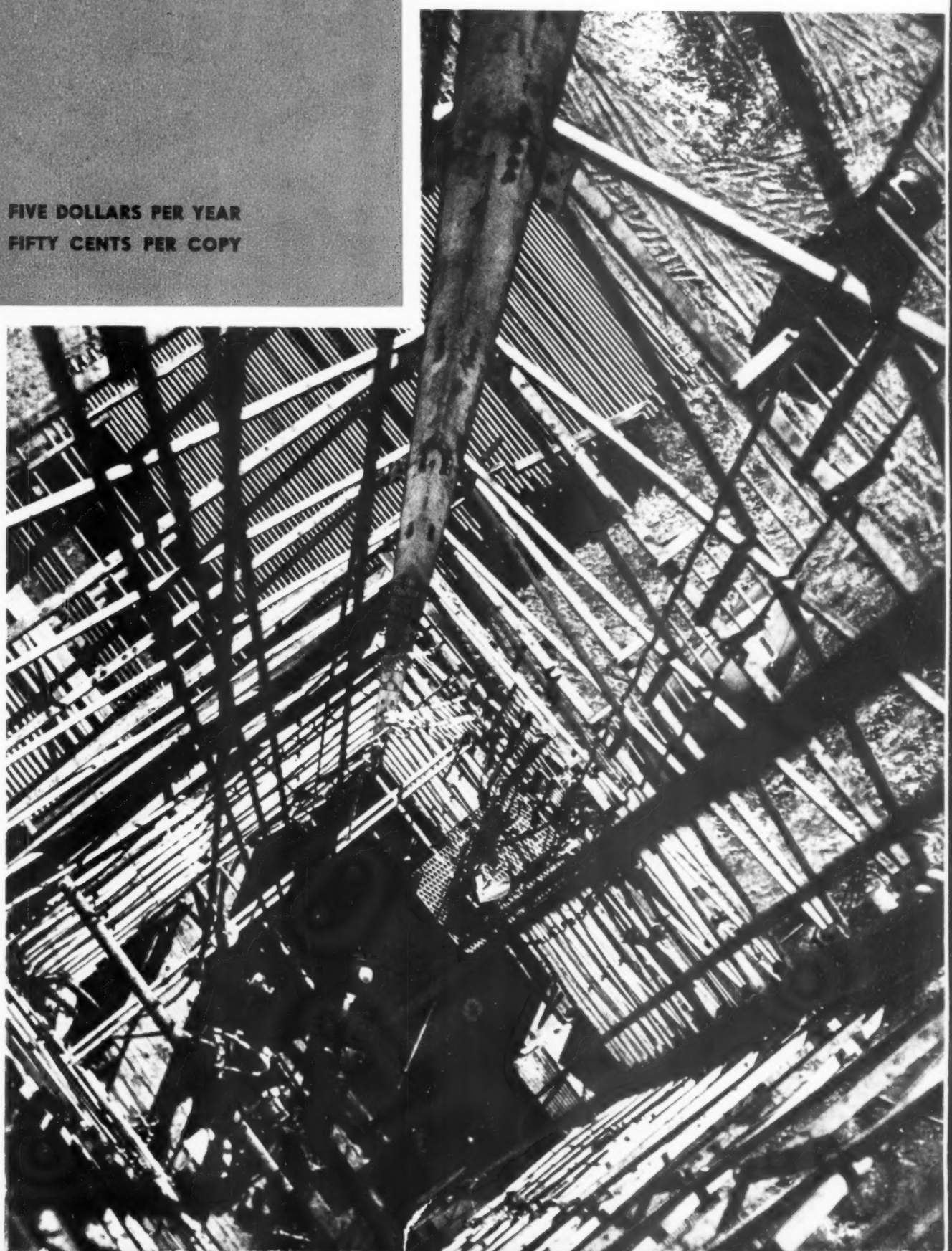

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WORLD PETROLEUM

Founded by Russell Palmer

PUBLISHED BY MONA PALMER

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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SUBSCRIPTIONS

Annual subscription $5.00 (U. S.) postpaid
Single copies 50 cents

GENERAL OFFICES

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(Tel. MUrray Hill 2-7333)

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World Petroleum is published by Mona Palmer, Trustee under the will of Russell Palmer

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THIS MONTH'S COVER—Looking down the derrick of Carter Oil Company's Mottiger No. 1 in McLain county, Oklahoma. Photograph by Corsini. Color plates courtesy Esso Oilways Published by Esso Standard Oil Co.

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DUNCAN, OKLAHOMA

EDITORIAL

OIL SITUATION NEARS STABILIZATION

DESPITE early predictions of a shortage in petroleum products during 1948, the figures of stocks have shown a steady growth from month to month. By the end of the first week in September the gain over the corrsponding date in 1947 for the four principal fuel products was over 18 percent, ranging from an increase of 10 percent in gasoline to 26 percent in residual fuel. This gratifying increase of 39 million barrels as compared with withdrawals of five million last year has been accomplished by raising crude production more than a half million barrels daily to keep ahead of the continuing upswing in consumption and by the operation of refineries at top capacity in converting this crude into products.

Progressive improvement in the stock position has been widely heralded in the daily press as evidence that the "oil crisis" has passed. Actually there has been no such thing as an oil crisis in the United States at any time since the end of the war. Tight situations in gasoline supply, or spot shortages as they were called, which occurred at various points in the central states during the summer of 1947, were attributable directly to inability to obtain steel for pipelines which had been projected for the movement of crude and products. As everyone knows, the extraordinarily severe weather of the following winter with snowbound railways and ice-blocked harbors in the northeastern states was responsible for delayed deliveries of heating oil which made some homes uncomfortable during the worst of the season. At the same time it is worth mentioning for the record that the oil companies employed every available emergency measure to provide adequate supplies for the territories they serve, including the movement both of crude and products by railway and truck where pipeline capacity was lacking or inadequate. In many cases this involved doing business at a loss, but that fact was not permitted to interfere with the primary object of protecting the interests of consumers. In order to build up a backlog of supply, oil companies have continued this practice during the current year and the tank car movement has remained much above the normal peacetime average while available tanker tonnage has been greatly increased.

As to the current supply position the outlook unquestionably is much more comfortable than it was a year ago. The peak of motor fuel demand which traditionally ends with Labor Day has been passed with the upward trend in stocks continuing and with allocations practically at an end. On the theory of averages the approaching winter should be less exacting than the one preceding, although the total requirements of fuel oil are expected to increase by 12 to 13 percent because of new installations of burner equipment. Conservative opinion among oil men holds to the view that there is still a need for urging householders to exercise care in their consumption of fuel and to see that their furnaces are put in condition for efficient operation. Some companies have lifted the ban against taking on additional contracts for heating oil, while others still adhere to the policy of discouraging new business.

While the building up of stocks to their present dimensions represents a noteworthy achievement on the part of the oil industry in view of the continuing upward course of demand, they cannot be considered excessive when measured by the number of days of supply represented, which is the only sound standard of determination. A slackening in their rate of increase may be anticipated in the near future through a slowing down of refining activity enforced by storage limitations. Growth in tankage capacity has not kept pace with the rise in demand, another manifestation of the handicaps imposed upon the oil industry by inability to obtain steel.

Concern has been expressed in some quarters at a weakening of prices in certain categories, specifically residual fuel and lubricants. As to the former the condition which has led to sales below recent quotations is again apparently a lack of storage capacity. Lifting of the ban on export, which already has been granted for some cargoes, should presently relieve this situation, as there is a strong unsatisfied demand from Europe for this fuel.

A sound appraisal seems to be that conditions in the oil industry are approaching stabilization. Premiums on crude are disappearing, a healthful manifestation. Product prices are steady with the exceptions noted which are due to special circumstances. It is noteworthy that while supplies of products have increased, crude stocks have declined and are now approximately six million barrels below their position a year ago. Should runs to stills slacken to some extent, crude stocks are in a good position to absorb an increase, as they might well be somewhat above their present state of 40 days' supply.

Conditions in the oil industry are capable of sudden changes as has been demonstrated on many occasions. As this is written a strike of oil workers on the Pacific Coast is imposing a drain on the Mid-Continent and Gulf Coast which, if continued, might materially affect the situation. A factor of potential consequence is in the hands of the Office of International Trade which might open the way to additional exports if convinced that such action would not injuriously affect the domestic situation, to meet the requirements of European countries participating in the ECA program.

FUEL SUPPLY OUTLOOK REASSURING TO CONSUMERS

THE postwar oil burner boom is over, at least for the present. The tremendous backlog of unfilled orders on the books of manufacturers has melted away so that there is no waiting list. Salesmen are out pushing doorbells. Refiners and fuel oil distributors are looking forward to a far less hectic winter than was their lot in the 1947-48 season. In general the feeling is that the industry is on the safe side with domestic fuel oil; residual fuel is in almost too plentiful supply at the moment, but kerosene is tight and there doesn't seem to be anything much that can be done about it.

Disappearance of the phenomenal burner market of 1947 is attributed to a number of circumstances. The fuel oil shortage scare of last winter is one important factor. Perhaps of almost equal importance is the tendency on the part of middle-class home owners to spend less money for expensive appliances because of the high cost of living and dwindling cash reserves.

Whatever the reason, the 800,000 backlog of unfilled orders is gone, and sales of new installations are only a third as great as a year ago. In the first half of the year new burner installations totaled 131,771, according to *Fueloil and Oil Heat* magazine. New burners installed last year totaled 823,675. Rate of sale of new installations is thus down from 6,900 per month to 2,200 per month.

Until the fuel oil situation began to clear up recently, the burner manufacturers were putting on a drive to sell replacement burners. New postwar models are far more efficient than older models and more is known about the value of better insulation of homes. A New York oil man who revised his home burner installation and improved the heat tightness of his home found that he could cut his fuel oil consumption from 3,600 gallons per year to 1,800 gallons per year. A mid-western burner manufacturer who put a crew of engineers in one city and surveyed all installations found similar savings possible in many instances.

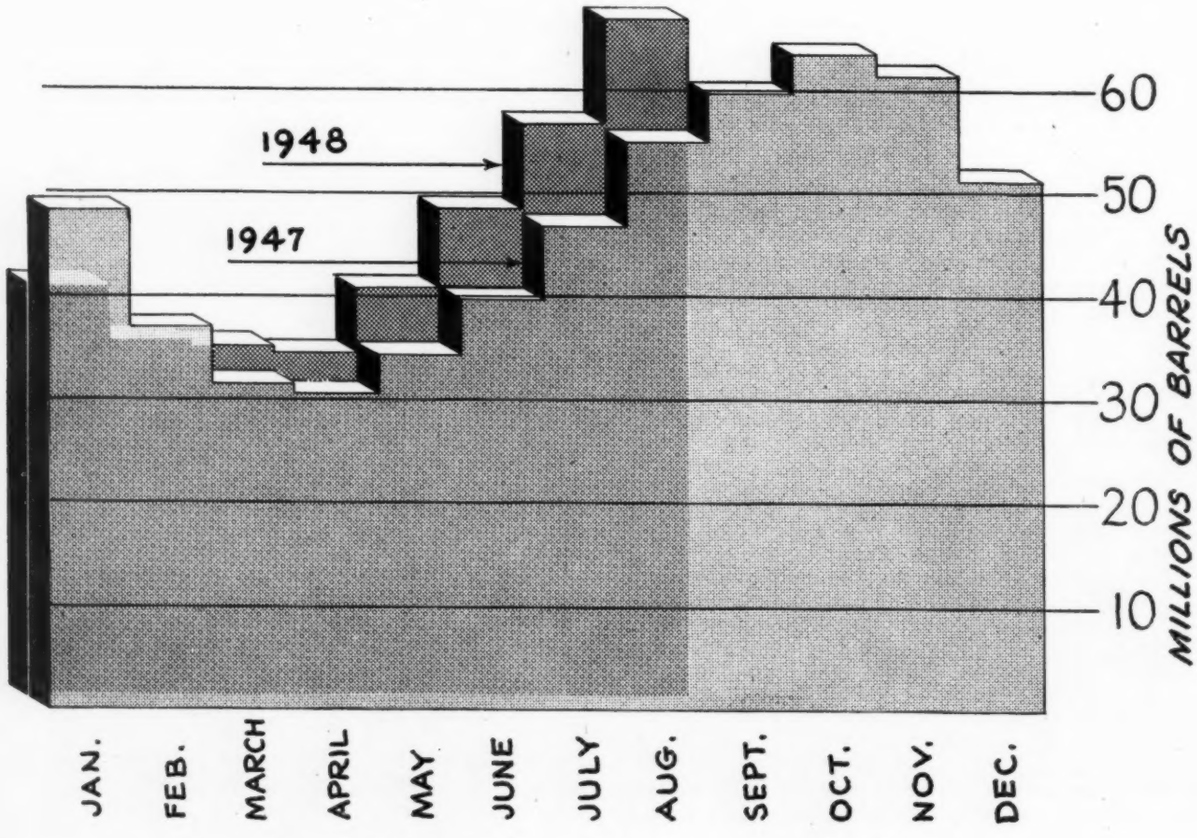
Result of the drive to sell replacement burners netted 45,946 orders in the first half of the year. This compares with 64,000 replacement orders in all of 1947.

Oil companies are sympathetic with burner manufacturers in their replacement drive, several being aggressive in offering surveys to their customers. One example is Shell Oil Company which has developed its own burner for sale to other manufacturers. Other companies also have flue gas analyzers and other heat survey services available for customers.

When it comes to taking off the lid and permitting distributors to make contracts for fuel to new installations, a majority of the largest companies are delaying a change in policy. In meetings in recent weeks at which the situation was canvassed, it was generally the decision to sell only to old customers and to newly-erected homes and not to encourage conversion of coal furnaces to oil. Viewpoint of the conservative companies is that they prefer not to make a change which they might have to reconsider next winter. If weather conditions should repeat the experience of last season, or if strikes should multiply, they do not want to be caught short.

Some of the large companies and perhaps a majority of the smaller independents have come to the conclusion that the threat of fuel oil shortage is definitely ended. They are busy showing prospective customers where to sign for next winter's oil supply. This viewpoint naturally is being encouraged by the burner manufacturers, some of whom have taken large advertising space in daily newspapers to quote a recent trade journal article to the effect that the oil shortage is over.

Current statistics of the industry suggest that the theory of a plentiful supply for the coming winter is correct. The margin of shortage last winter, one of the most severe in years, was said to have been only a half of one percent. The industry came that close to meeting all demands with a shortage of tankers to bring supplies from the Gulf to the Atlantic seaboard and in the face of adverse weather.



Stocks of gas oil and distillate fuel have been higher than a year ago since the end of March and now exceed the pre-season peak of 1947 by a substantial amount.

This year the tanker capacity is fully equal to all prospective requirements, according to calculations of the National Petroleum Council. A review of the tanker situation in the September issue of WORLD PETROLEUM tends to support this conclusion. Tanker capacity is 63 percent greater than prewar, while demand for petroleum is up 47 percent.

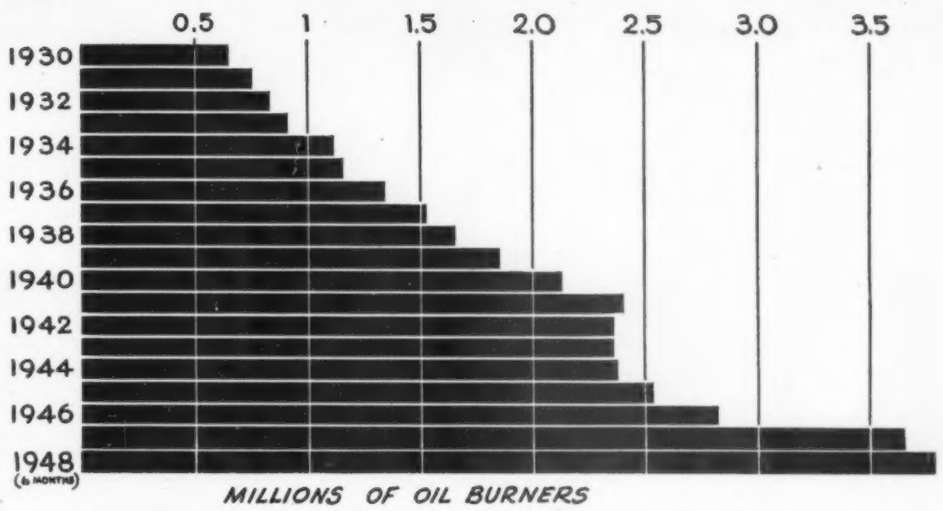
In addition the distributing branch of the industry has bought all the tankage it could lay its hands on in recent months to augment local storage room adjacent to consumers. This storage is being filled before the season opens. Current reports of the American Petroleum Institute reflect the more comfortable stock position at points distant from field refineries. The September 11 stock of gas oil and distillate fuel oil in terminals and refinery storage on the East Coast was 4,290,000 barrels higher than a year ago, whereas refinery stocks on the Gulf Coast were only 2,014,000 barrels above a year ago. Indiana-Illinois terminal and refinery stocks were 3,399,000 barrels higher than a year ago, these also being located only a short haul from consumers.

Stocks of residual fuel oil at refineries and primary terminals are 27 percent higher than a year ago. Of the 72 million barrels of heavy fuel in stock early in September, a larger than normal quantity was on the eastern seaboard adjacent to heavy consuming centers. The industry policy of discouraging new users of heavy fuels plus the greatly expanded crude runs have created a storage reserve which has used up about all the available room. Currently some refiners are seeking a temporary outlet to Europe under the ECA to relieve the temporary shortage of tankage. It is considered wiser to move the surplus overseas rather than to take on any new customers who might have to be cut off again in a few months.

Pipeline facilities to help speed fuel oil to customers have been improved also during the past year. An example is the 127-mile line Socony-Vacuum Oil Co. has laid from Portland to Bangor, Maine. This line will free the company of delays which often impeded or halted oil barges several weeks each winter. Now only local, short hauls will be required to make deliveries of furnace oil and kerosene.

The overall stock situation on gas oil and distillate fuel has been improving every month since the close of the heating season, as may be observed in the accompanying chart. The 66.4 million barrel stock at the end of August was greater than the peak attained on October 31 last year when the season opened. If the present rate of accumulation is continued through October, it may be that stocks will reach or exceed 90 million barrels by November 1. The August stock increase was 10 million barrels and at the end of the month was 12 million barrels above the same period last year.

Consumer storage undoubtedly is higher than ever before at this season of the year, although there is no means of estimating the added volume. Every home owner who followed the widely publicized advice of the oil companies has his tank full today, and consumer storage capacity is greater than in previous years. Burner distributors have been busy selling as many large supplementary tanks as they could obtain and have found a ready market among home owners who want to be on the safe side.

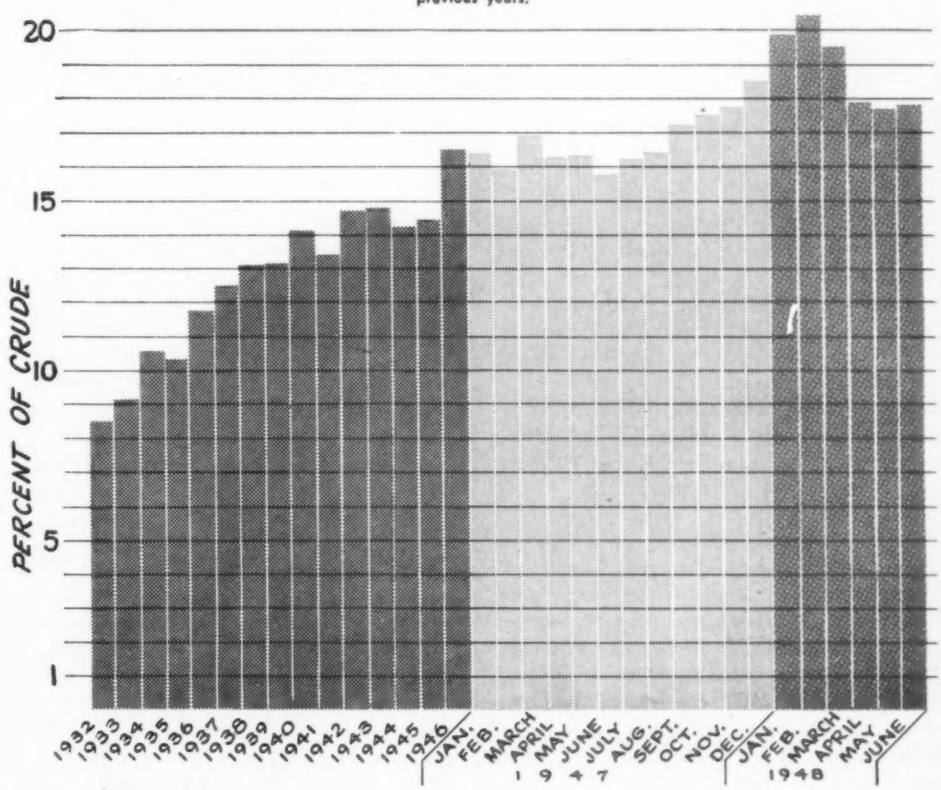


Rate of increase in oil burner installations has returned to about the pre-war level after the 1947 boom.

Refiners and bulk terminal operators have been able to build up their stocks of middle distillates more rapidly because no shortages of gasoline developed, as some had feared, to force refineries to run for maximum motor fuel. With the gasoline supply situation comfortable throughout the peak season, refiners have kept distillate yields higher than ever before. In June 1946 United States refinery yields of gas oil and distillate fuels were 16.1 percent of crude. Last year in June the yield was 16.3 percent. This year, however, the yield was 17.8 percent of crude runs to stills. An accompanying chart traces the yields of gas oil and distillate fuels for the past sixteen and one-half years since 1932 when the average was only 8.47 percent of crude. Last February in the peak of the cold weather demand, refiners ran their yields up to 20.6 percent, the highest in history and at a level which disregarded profit considerations.

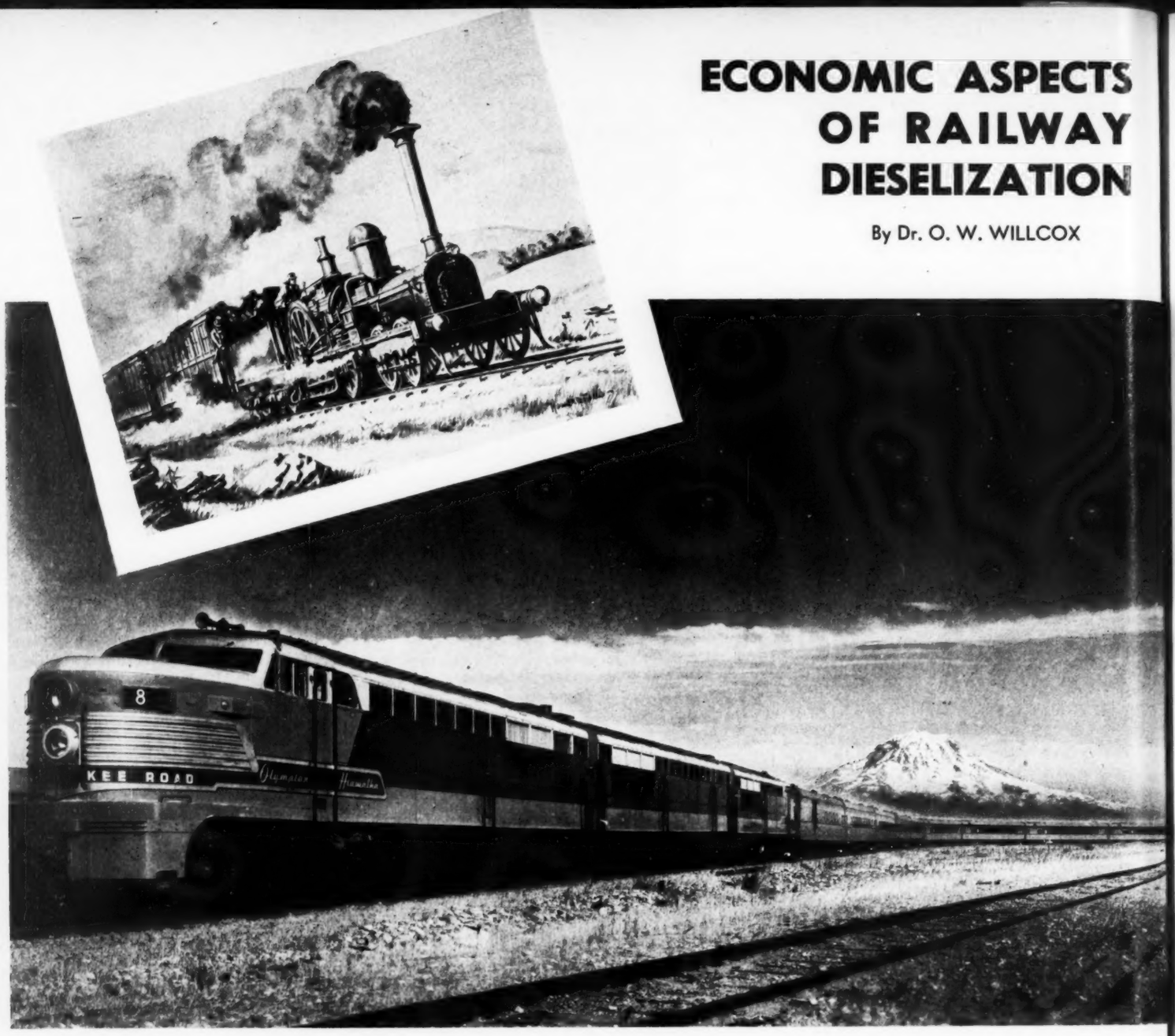
(Continued on page 72)

Refinery yields of gas oil and distillate fuel oils in the first half of 1948 have been kept well above previous years.



ECONOMIC ASPECTS OF RAILWAY DIESELIZATION

By Dr. O. W. WILLCOX



A century of progress in railroad transportation. Above is a drawing of the "Lightning", first locomotive built at the American Locomotive Co. plant in Schenectady in 1848. Below is the Olympian Hiawatha diesel-electric train which operates between Chicago and the Pacific Coast. American Locomotive expects to build diesel locomotives.

RECENT studies by fuel experts indicate that complete dieselization of American railways not only will save the transportation companies more than half a billion dollars annually in the cost of fuel and of its transportation but will be of benefit in increased efficiency, reduced operating costs and in many other ways. At the same time it will work to the advantage of the oil industry by replacing great amounts of fuel oil now consumed in steam locomotives with lesser quantities of higher grade fuel.

That the movement in this direction is well under way is shown by the fact that in the first half of 1948 the railways of the country used over 13,000,000 barrels of diesel fuel, an increase of 54 percent over the corresponding period of 1947. In a recent statement by Robert B. McColl, president of American Locomotive Company, he pointed out that 20 percent of the steam locomotives are oil burners and use 227,485 barrels of liquid fuel daily. With complete dieselization only 170,343 barrels of diesel oil would be required. Mr. McColl estimates that 20,000 diesel-electric locomotives will be required to replace the 35,000 steam units now in use and that the process will extend over the next ten years. His confidence in the completeness of the revolution now under way in railway fuels, not only in the United States but also in other countries, is indicated by the fact that his company has discontinued the building of steam locomotives and is concentrating its facilities on diesel-electric production.

As is generally known the railroads of the United States burn three categories of fuel in the operation of their locomotives; coal, heavy or residual fuel oil, and diesel oil. The proportions of these fuels in use during recent years has been shifting markedly. Between 1944 and 1947 the consumption of coal has declined 19 percent and that of heavy fuel oil 10 percent, while consumption of diesel oil has increased 152 percent. In 1940 the number of diesel locomotives in the country was 967; by the end of 1947 this number had increased to 6,100. The current rate of production of these engines is about 1,800 a year.

This summary comparison may be taken as an indication that economy of operation is counting heavily in favor of diesel oil, which means of course that the case of diesel engines vs. steam engines is being decided in favor of the diesels.

One reason for the preference shown for the diesel engine by the railroads is that it is thermodynamically superior to steam engines; that is it converts a larger proportion of the heat unit to the fuel into power units. From the financial standpoint this thermodynamic superiority of the diesel makes itself felt in the railroads' expense accounts as savings in two main items—cost of fuel, and the expense incurred by the railroads in bringing the fuel to the points where it is

needed. The magnitude of this latter item is apt to be overlooked.

In comparison with coal and heavy fuel oil, it costs relatively little to haul equivalent amounts of diesel oil. This is due to the too little appreciated fact that there is a great difference in the weights of the different kinds of fuel to produce one service-unit of power. This has been brought out by a digest of recent ICC figures made by N. D. Ballantine for Railway Age.

For example, per engine-hour in yard service, where diesel oil consumption was 46.44 lbs., the weight of fuel oil consumed was 11.9 times and the consumption of coal was 19.6 times greater. When the comparison is made on the basis of 1,000 gross ton-miles in freight service, the weight of diesel fuel was 12.24 lbs; fuel oil was 5.97 and coal 11.19 times more. In road haul passenger service per passenger-train car-mile, the weight proportions were: diesel oil 2.09, fuel oil 4.6 and coal 10.29 lbs. These figures are shown in Table 1.

Table 1

Comparative Weights of Locomotive Fuels.

	Lbs.	Ratios
per switch engine hour		
Diesel oil	46.44	100.0
Heavy fuel oil	552.60	1190.0
Coal	910.00	1960.0
per 1000 gross ton-miles (freight)		
Diesel oil	12.24	100.0
Heavy fuel oil	73.02	596.6
Coal	137.00	1119.3
per passenger-train car-mile		
Diesel oil	2.09	100.0
Heavy fuel oil	9.61	459.0
Coal	21.50	1028.7

These differences in service-unit weights of locomotive fuel show up strongly in the out-of-pocket expense to which the railroads are put for transporting their locomotive fuel. This is illustrated by analysis of figures that reflect operations for the month of March, 1948. In that month the combined weight of coal and fuel oil consumed was 6.84 times the weight of the diesel oil which would have been required to do all the work; in other words, 221.8 million gallons of diesel oil have been equal to 296.2 million gallons of fuel oil plus 7,888,419 tons of coal.

On the basis of experience in this one month, and assuming that if the whole motive power of the railroads were put on a diesel basis, the shrinkage of the weight of fuel hauled would be as shown in Table 2.

Table 2

Savings in gallonage of liquid fuel hauled by supplanting fuel oil diesel oil—March 1, 1948

Class of Service	Fuel Oil (1000 gals.)	Diesel Oil Required to substitute (1000 gals.)	Savings (1000 gals.)
Freight	206,143	152,869	53,274
Passenger	63,044	47,609	15,435
Yard	26,998	21,308	5,690
All Services	296,185	221,786	74,399

This table shows that by supplementing fuel oil with diesel oil, in one month the railroads would have had 74,399,000 gallons less of liquid fuel to handle.

Combining coal and fuel oil on the basis of tonnage hauled, the savings would be as shown in Table 3.

Table 3

Savings in tonnage hauled by supplanting both coal and fuel oil with diesel oil—March, 1948

Class of Service	Coal plus Fuel Oil (1000 tons)	Diesel Oil Required to Substitute both (1000 tons)	Savings (1000 tons)
Freight	6,285	550	5,735
Passenger	1,432	171	1,261
Yard	2,463	766	1,697
All Services	10,180	1,487	8,693

Railroad accountants usually wind up by expressing such items in terms of number of cars in use and gross ton-miles of haulage. On this basis the comparison of car use is shown in Table 4.

Table 4

Savings in car use by supplanting present use of coal and fuel oil with diesel oil—March 1948.

Class of Service	Cars in Use for Coal and Fuel Oil*	Cars Needed for Diesel Oil	Savings in No. of Cars
Freight	57,942	3,287	54,655
Passenger	12,622	1,026	11,596
Yard	13,302	456	12,846
All Services	86,866	4,769	79,097

* Based on estimated 15-day turn around for coal cars, six days for tank cars.

Supplanting present use of coal and fuel oil with diesel oil as locomotive fuel would free 79,097 cars for other use.

Table 5

Savings in gross ton-miles by supplanting present coal and fuel oil consumption with diesel oil—March, 1948

Class of Service	Combined Mileage Coal plus Fuel Oil	Mileage if Diesel Oil is Substituted for Both	Savings
Freight	2,352,594	267,788	2,084,806
Passenger	541,232	82,955	458,277
Yard	983,736	337,402	646,334
All Services	3,877,562	688,145	3,189,417

Table 5 means that gross ton-miles now expended in hauling coal and fuel oil for locomotives could be reduced from 3,877,562 to 688,145 by supplanting both with diesel oil. This would be a saving of 563 percent in mileage.

The eventual payoff comes when the foregoing physical magnitudes are translated into terms of equivalent cash. It will be remembered that the figures in Tables 2 to 5 represent one month's consumption of locomotive fuel by Class I railroads. The relations of quantities and costs are given in Table 6.

The demonstration from these computations is that the substitution of diesel-electric locomotives for all of the steam power on Class I road-

Table 6

Consumption and cost of locomotive fuel—March, 1948

Service	Coal Used, tons	Fuel Oil Used, gallons
Road, freight	5,409,598	206,142,979
Road, passenger	1,164,153	63,044,226
Yard	1,314,688	26,997,909
Combined	7,888,419	296,185,114
Diesel oil to replace both		221,786,382
Net reduction in fuel	7,888,419	74,398,732
Costs		
Cost of coal @ $5.02 a ton		$ 39,599,863
Cost of oil @ $5.45 gal.		16,142,098
Combined cost coal and fuel oil		$ 55,741,952
Cost of diesel oil substitute @ $10.43 gal.		$ 23,132,320
Reduction in fuel cost, 1 month		$ 32,609,632
Yearly rate of fuel savings		$391,315,584
Add saving in cost of transporting coal and fuel oil locomotives		$191,245,020
Combined estimated yearly savings		$582,560,604

haul and terminal railways of the United States would mean the annual saving of $582,560,604 from just two items alone—the cost of fuel, and the out-of-pocket expense of transporting it.

Another phase of the matter is that if the coal-burning and fuel-oil burning locomotives now in use are discarded they will have to be replaced not by an equivalent number of diesel engines, but by an equivalent amount of diesel horse power. ICC statistics show the assignment of locomotives by types and class of service, but do not give information as to the number of locomotives that are active, stored or unserviceable; by collating certain known facts it has been possible however to make fairly good estimates, as shown in Table 7.

Table 7

Estimated diesel requirements to replace steam locomotives—March, 1948.

Class of Service	Steam Locomotives Displaced	Diesels to Buy	Equivalent Horsepower (000)	Cost per hp	Total Cost (000)
Freight	19,644	10,169	26,863	$100	$2,686,363
Passenger	5,169	3,198	5,829	100	582,927
Yard	9,918	5,942	5,942	90	534,780
Total	34,731	19,309	38,635	$ 98	$3,804,071

Table 7 shows that the estimated cost of displacing all presently used steam railway locomotives would require a gross capital investment of $3,804,071,100. This gross capital outlay may be offset by certain capital credits, as follows:

Scrap value of 34,831 steam locomotives	$ 119,088,000
Value of 79,097 released freight cars	237,291,000
Offset credit to capital account	$ 356,379,000
Net capital investment	$3,447,692,000

The net capital investment for complete dieselization of Class I railways in the United States would thus be $3,447,692,100. This would be a sizable investment, but with an annual saving of $582.56 million in just two items —the cost and the transportation of locomotive fuel—an investment of $3,447 million in new diesel locomotives could be paid off in 5.9 years.

Combination heavy-duty switch and road engine powered with a 2,000 hp. Fairbanks-Morse diesel engine.

The railroads would probably have difficulty in attracting that much venture capital, but since the investment is for motive power they could issue equipment certificates, which are the easiest of all railway securities to float.

Aside from the direct cash savings there would be important indirect advantages. The freeing of 79,097 cars now tied up in the haulage of locomotive fuel would be a help. Right now the railroads need 12,000 new cars a month. The scrapped steam locomotives would help to relieve the steel shortage. The general public would have access to 227,485 more tons of coal per day. The oil situation would be relieved by the substitution of 170,343 barrels of diesel oil per day for 277,485 barrels of fuel oil; that is, instead of producing 100 barrels of fuel oil from a given amount of crude oil, the oil refiners would need to produce only 75 barrels of diesel oil.

Other indirect benefits would come from elimination of the present expensive operation of roundhouses, coal and water stations and other facilities. Tank facilities for diesel oil would be only 75 percent of the tankage for fuel oil. Maintenance of roadbed would gain from the fact that the drive wheels of steam locomotives are close together, which means that their weight is concentrated within a relatively short distance, and with their tenders they have nearly as many more non-driving wheels, which means extra pounding of the rails. Car repairs would certainly be less. With the relatively large tractive force of diesels at starting, and with properly trained diesel engine men, drawbar pull-outs will decrease. The damage to freight cars from the jerks of steam engines and damage to freight cargo will involve less expense, and it is even worth while to mention that the rear-end-crew on a long steam-drawn train will get much less shaking up. No data are available for making an estimate of the cash values of some of these subsidiary benefits, but there is little doubt that they will be considerable.

Another direct saving would result in a decrease of the overtime pay of train crews. For instance, the straight-time pay of a train crew of five men in March, 1948, averaged $6.98 per hour; their pay for overtime averaged $9.84 per hour. When the speed of freight trains averages 25 miles per hour the crews receives a day's wages for four hours work. The step-up of train speeds that is possible with diesel locomotives would have an important bearing on the cost of labor in train operation.

The final conclusion is that it should be very much worth while to substitute diesel power for steam power at the earliest practicable date.

The first question then is: Where to begin with the substitution? Should the coal burning steam locomotives or the oil burning locomotives be the first to go?

An answer to this question may be obtained from a further breakdown of the data in Table 6, which supplies the figures in Table 8.

Table 8

Service—unit costs of operating railway engines —March, 1948.

Diesels	Coal Burners	Fuel oil Burners	Ratios
	Per Switch Engine Hour		
$0.673	$2.284	$3.543	1:3.39:5.26
	Per 1000 Gross Ton Miles		
$0.177	$0.344	$0.468	1:1.9:2.64
	Per Passenger-train Car-miles		
$0.030	$0.054	$0.062	1:1.8:2.06

The information in Table 8 may be supplemented by the data in Table 9.

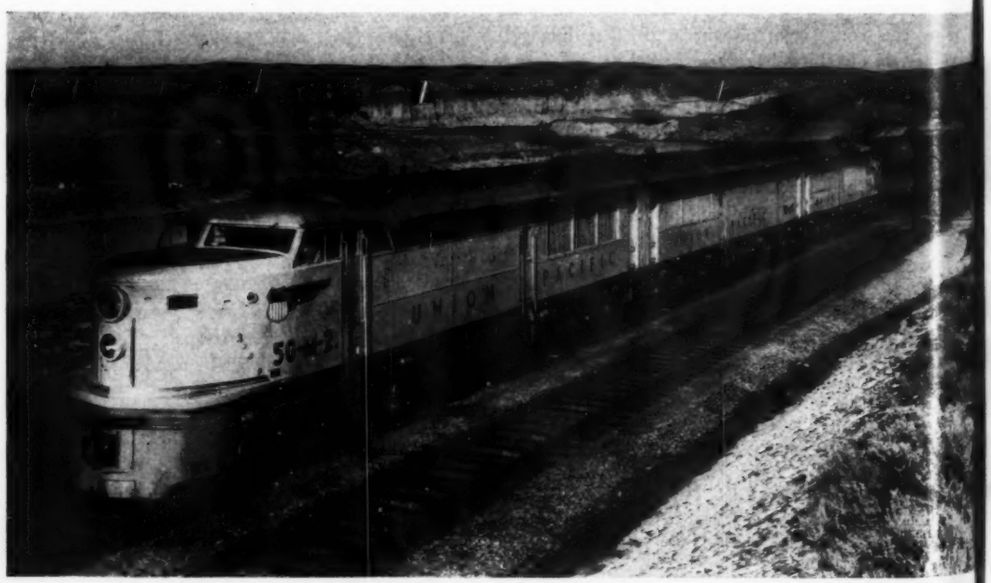
Table 9

Tons hauled per ton weight of locomotives and tenders in freight service*—March, 1948.

Kind of Locomotive	Tons Hauled	Ratios
Fuel oil burners	6.74	100.0
Coal burners	7.11	105.6
Diesels	8.69	128.9

The figures in Tables 8 and 9 point to the conclusion that the fuel oil burning locomotives should be the first to go, and they should be followed, with as little delay as possible, by the coal burners.

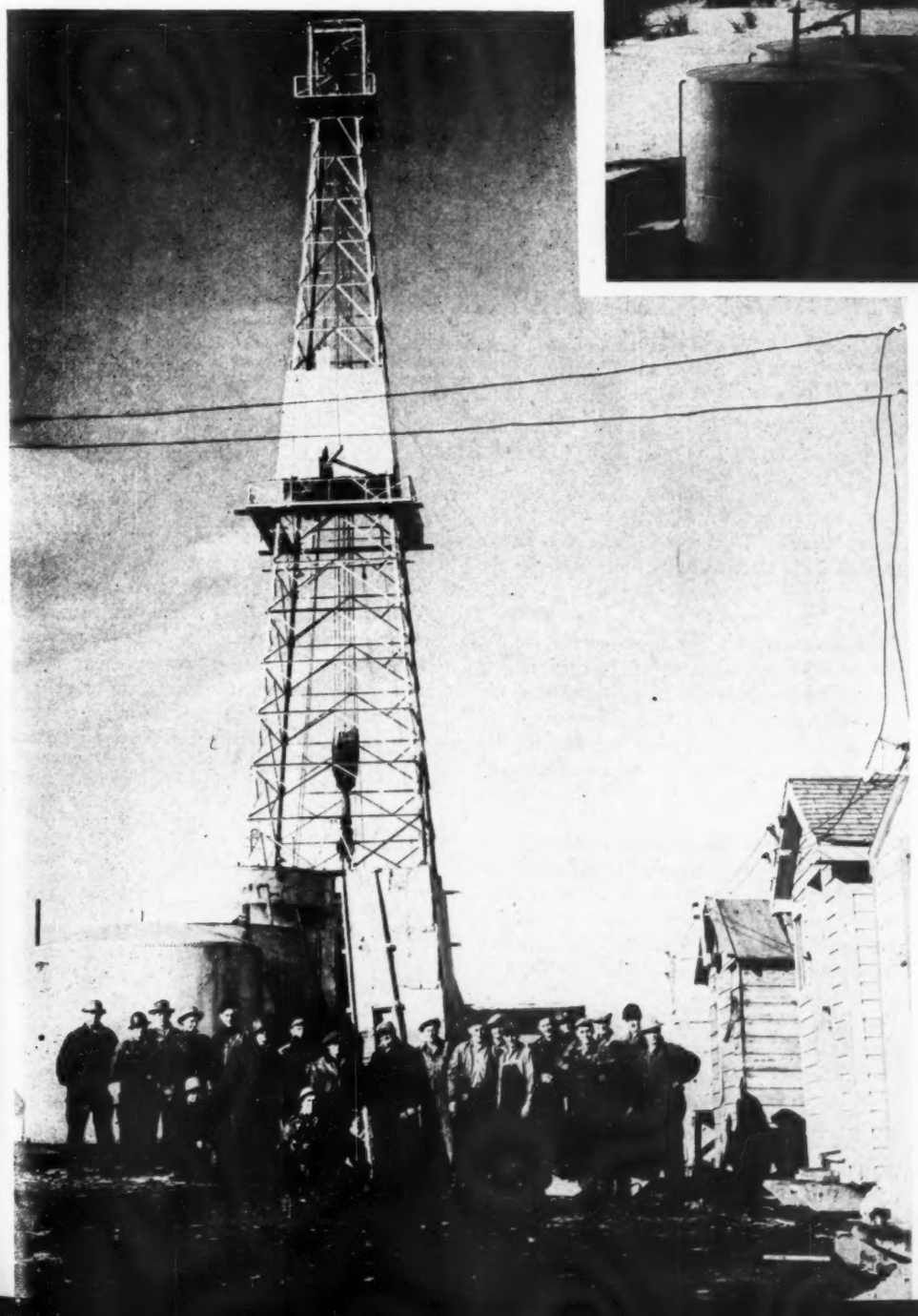
* Similar data are not available for passenger service.



The world's first opposed-piston diesel road passenger unit built by Fairbanks-Morse for use by the Union Pacific on the Los Angeles Limited.

CANADA'S PRODUCTION TAKES UPWARD TURN

↑ The Turner Valley field in Alberta has been one of the principal oil sources in Western Canada for many years.



← Drilling crew which completed Leduc No. 1 for Imperial Oil Ltd., rich discovery which set off a big drilling campaign. Photographs by Corsini for Standard Oil Co. (N. J.).

A MILLION and a quarter barrels of oil from the Leduc field during the first half of 1948 has stopped the decline in Canadian production which had continued for the past five years and has turned it into a positive gain of approximately that amount as compared with the corresponding period of 1947. Turner Valley production continued to fall but it is noteworthy that the decrease was only about half that which took place in the first six months of 1947. Lloydminster raised its outturn over the 1947 half year by upward of 400,000 barrels.

These were the principal changes and they accentuate the predominance of Alberta as a Dominion oil producer with nearly 80 percent of the total Canadian outturn. Production for the two half-year periods is shown by provinces in Table I.

Alberta's production in June 1948 established an all time record with a total of 900,508 barrels, an average of 30,017 barrels daily. A total in excess of 6,000,000 barrels is expected for the

An entire 40-acre area was enveloped in flames on September 6 when Atlantic No. 3 burst into flames after having been out of control since March 8. Fortunately most of the preliminary relief well drilling was completed before the fire broke out.

Relief wells around the blazing crater of Atlantic No. 3. Slightly to the left of the fire is the West relief well. South relief is at the far right. Imperial No. 48 in the foreground was used as a water injection well in an attempt to drown out Atlantic No. 3.

province for the latter half of the year. This would confirm the estimate made at the beginning of 1948 that Alberta would finish the year with a total of between eleven and twelve million barrels, a record to compare with the previous high mark established in 1942 of 10,136,296 barrels. Cumulative production of Alberta fields up to June 30 last was 101,604,671 barrels. In June last of this year, Leduc passed Turner Valley and took first place among Canada's producing oil fields. The June figure was 398,829 for Leduc to compare with Turner Valley's 371,305.

The Leduc field is now becoming known as Leduc-Woodbend. Woodbend adjoins it on the north and the Saskatchewan River separates the two.

Woodbend made its first appearance as a productive area near the end of January of this year. The first well, drilled in the center of the township was a D^3 producer. Now there are five D^3 producers fairly close together on this new ground. Drilling continues and is being pushed out to different points of the compass.

It has not been finally determined whether Woodbend is a continuation of Leduc or a separate pool. A dip to the north of 52 feet between Leduc West's Nos. 3 and 4 wells, a quarter of a mile apart, created the opinion that Woodbend might be a second field.

The two wells last mentioned were the field's most northern producers. Since then two more wells, drilling farther north, missed the D^3 and were compelled to ream back and drill directionally to the south to reach the zone.

Drilling on the immediate north bank of the Saskatchewan should confirm or disprove the theory as to a dividing line.

Two outstanding events in the half year under review are closely related to Leduc-Woodbend's development. They are the reassembly of the Whitehorse refinery, transported in sections to Edmonton to process some of Leduc's heavy production, and the dramatic appearance of Leduc's rebel well, Atlantic No. 3.

The story of the refinery and its travels has been given before.*

Official opening took place on July 17 of this year when the first stream of gasoline flowed into the first railway tank car. The site of the new plant covers 360 acres of the farm land adjoining the Saskatchewan River. Spurs of the two transcontinental railways have made connection with it, and the pipe-line from Nisku, 18 miles to the south, will service the new refinery by September. Nisku is the present railhead terminal of the pipeline from the Leduc field.

* See WORLD PETROLEUM, May, 1948.

Table I

Oil Production by Provinces
Six Months—Jan.—June

	1947 Barrels	1948 Barrels		Changes
Alberta	3,235,453	4,469,997	+	1,234,544
Saskatchewan	164,456	374,065	+	209,609
Northwest Territories	118,429	190,175	+	71,746
Ontario	56,099	80,304	+	24,205
New Brunswick	12,144	9,835	+	2,309
Totals	3,586,581	5,124,376	+	1,537,795

Present capacity is 4,000 barrels per day, which are hauled over the 28 mile route from the field, involving 100 tank truck journeys daily. By the end of the year capacity will be raised to 6,000 barrels. The further raising of this capacity to 11,000 barrels daily is under consideration for next year to cost around $2,500,000. It is estimated that with a daily throughput of 6,000 barrels, the country will be saved in the neighborhood of $6,000,000 yearly in scarce American dollars by replacing imports, and a further $1,000,000 by eliminating transportation which would have to be paid for in dollars.

The second week of September marked finis for Canada's wild well in the Leduc, Alberta, field, following nearly six months of uncontrolled fury. After spewing oil and gas over the surrounding countryside despite efforts of wild well experts, and after dramatically bursting into flames on the afternoon of Labor Day, the fire and the flow of petroleum was snuffed out by means of a directional relief well drilled under the supervision of engineers of the Houston Oil Field Material Company, of Houston, Texas, specialists in work of this type.

Blowing out initially in March of this year, the wild well, Atlantic 3, flowed hundreds of thousands of barrels of pipeline oil, with production ranging from 7,000 to 14,000 barrels daily, along with 30,000,000 to 50,000,000 cubic feet of gas. With extraordinary precautions observed as fire prevention measures, fire was averted until Labor Day, which dramatically marked the same day that the bit of the directional well penetrated the D^3 formation to permit quick water flooding and subsequent killing of the well.

Almost all known methods of killing the rampant well were used during its life, but all direct methods failed. Tons of cement, chemical muds, wood fiber, feathers, and other sealing materials were pumped into the hole. Nitroglycerine blasts proved fruitless. About 70,000 barrels of water were pumped into a nearby well from the Saskatchewan River for underground flooding, but only served to repressure the formation and increase the flow from Atlantic 3.

Oil disposal facilities were inadequate to handle the surplus oil, forcing producers to shut in all other wells in the field for several weeks while extra transportation methods were developed. Many barrls of surplus oil were pumped underground as a means of temporary storage, to be produced again in the future.

Two directional wells were drilled, one each from the South and the West, both racing against time to reach the charged D^3 zone of the Devonian, found at about 5200 feet. South Relief well spudded first, and was the first to reach the green shale which overlies the D^3. Difficulties in running casing were encountered, resulting in the accidental sidetracking of the directional hole at 3700 feet, and this relief well had never succeeded in reaching its former depth at the time Atlantic 3 was killed. West Relief, under the supervision of Houston Oil Field engineers and getting off to a later start, tapped the green shale and ran protective casing late in August. After allowing the cement to set for four days, drilling commenced, and the D^3 was penetrated at a point within eight feet of the calculated position of the bottom of the cratered hole.

Coincidentally, on the very day that the bit first entered the D^3 formation, Atlantic 3 burst into flames. Almost the entire 40-acre tract surrounding the well became a raging inferno, with oil and gas worth an estimated $50,000 daily going up in smoke. With heavy pumping equipment already set in position at the casinghead of West Relief, water was pumped into the formation far below. Starting by injecting 550 barrels of water hourly, the rate was increased to 1350 barrels. Within a few hours after attaining the maximum rate of injection, water returns began to appear at the surface of the crater. After 17 hours of sustained pumping, the blaze was snuffed out; in less than two additional hours, Atlantic 3 was dead.

Extension to the Leduc field have enlarged it considerably to the north, west and south. To be added to these is Continental's latest extension in the northeast, north of the river, and just east of the Woodbend township. Continental No. 3 came heavily into production from the Lower Cretaceous above the Devonian after the latter had given negative results. Both gravity and volume of the oil were equal to an average Devonian producer.

This discovery may be regarded as one of the most important yet made in the area. To produce 40° gravity oil from this shallow depth—4,205 feet—with flush production around 1,000 barrels a day was news of great importance. Drilling had finished at 5,526 feet in the limestone. The D^2 was unproductive and no D^3 was discovered.

The well was plugged back, casing set at 4,250 feet and the Lower Cretaceous was tested at 4,205 feet. On the first test there was water with the oil. It was discovered to be coming from above and the upper zone containing it was sealed off. Production is now reduced to an estimated 250 barrels daily. No restriction on production from the Cretaceous has as yet been announced and it is understood that one well from each 20 acres is permitted from this particular zone. This points to a program of considerable testing of this zone, particularly in the northeastern part of the field.

Great possibilities for the area are presented by this discovery. With the prospect of establishing a 3-zone field production totals may become greater than previously anticipated. The productive area of this zone can only be answered by further drilling.

Potential of the whole area was estimated last year to be 80 million barrels. Then it was raised to 100 million, and later to 200 million. It will go further, has already done so as a matter of fact, resulting from the appearance of Continental No. 8 in the southwest which came in as a D^2 producer, with flush production of 1,800 barrels a day, one of the best of that zone in the field.

The result of this was that some four square miles of new proven territory were added to the field, which means around 250 new drilling sites of 40 acres each if it proves to be a one zone area, and twice that amount if there should be two. Then again there is always the possibility of the Cretaceous up above.

Production in the Lloydminster field which lies partly in Alberta and partly in Saskatchewan is increasing rapidly and at the end of the half-year was going at the rate of over one and a quarter million barrels annually. Its heavy black oil which was poorly regarded a few years ago has proven its suitability for many products such as high octane gasoline, fuel oil, Diesel oil, excellent grade asphalt, bunker fuel for railway locomotives, industrial fuel and particularly lubricating oil. Naphthenic lubricants, such as Lloydminster can produce, are stated to be superior because they have properties which have the ability to dislodge or prevent carbon in internal combustion engines.

This big area runs about 34 miles from northeast to southeast. In it are the producing fields of Lloydminster, Blackfoot, Silverdale and Lone Rock. Producing depths are around 1,900 feet and gravity runs from 10° to 16° and even higher on occasion.

In preparation for present and future advances, refinery expansion at Lloydminster is in evidence. There are two plants. The larger is that of Husky Oil and Refining Limited. With a previous capacity of 3,500 barrels daily, and an increase to 5,000, the plant is now preparing to expand again to 7,500. The second plant, the Excelsior, has enlarged its capacity from 1,200 to 2,000 barrels daily.

Adjoining the Husky is the plant of the Flintkote Company of Canada, which produces an asphalt road emulsion known to the trade as "Colas," which has been used successfully for many years in eastern Canada. Consideration is also being given by the Saskatchewan Power Commission to the erection at Saskatoon of a topping plant for the recovery from Lloydminster's oil of marketable products of light ends, leaving the balance available as fuel.

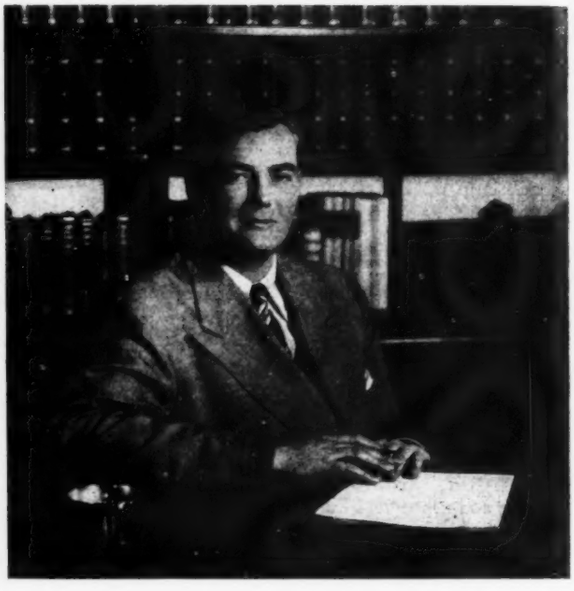
With the exception of New Brunswick, all provinces of Canada show increased production for the present half year. Last year only the Northwest Territories and Saskatchewan provided increases. The half year in 1947 for all Canada revealed a decrease of 278,483 barrels from 1946 to compare with this year's increase of 1,537,899.

Other producing oil fields of Alberta are Taber, Conrad, Princess, Vermilion, Wainwright, Del Bonita, Dina, Bantry and Jumping Pound. Princess, Taber and Conrad are the largest producers at present. Production from Princess is increasing steadily and in June this field took the lead in the "other fields" category with a total of 19,555 barrels for that month.

GEOPHYSICS AS A FACTOR IN THE OIL INDUSTRY

By M. V. Yale

Shot hole rig in Porto Rico.



Herbert Hoover, Jr., president of United Geophysical Co.

GEOPHYSICS has become such an integral part of the petroleum industry and its use so nearly a routine feature of the search for oil that it is difficult to realize that it is a relatively recent addition to the scientific aids to exploration. Also, in view of the rapid development and widespread use of geophysical methods by Americans, it is a trifle disconcerting to recall that this system of exploration did not originate in the United States. While today there are scores of firms with staffs consisting of thousands of technically trained and practically experienced members engaged in geophysical surveys, a mention of the term would have brought nothing but a blank look from the average oil man a generation ago. Even the geologist who by that time had won a place for himself in oil company organizations was not too highly regarded by some of the oldtimers who had followed a system of trial and error in their efforts to locate oil.

Three decades ago geophysical surveys by contracting companies were unheard of. First in the field were the all-German crews who came to the United States around 1921 with their torsion balances and other precision instruments, and who kept their instruments and technical data under lock and key in order to maintain a monopoly as long as possible. Shortly thereafter the Americans started buying and developing their own instruments, and within a few years geophysicists of the United States had taken over the lead. First American torsion balance crews in foreign work were two sent to Maracaibo and Maturin in Venezuela by the Standard of New Jersey in 1926.

Great improvements had been made in geophysical instruments by 1931, the torsion balance having given way to the gravity meter and the refraction seismograph having been supplanted by the more accurate and faster reflection seismograph shooting. New developments in seismic techniques now include smaller and lighter seismometers, electromagnetic type detectors, improvements in time devices, multiple seismometers, electric filters, portable automotive shot hole drilling rigs and the development of continuous profiling. The flying magnetometer, outgrowth of the late war, has attracted much attention because of its spectacular nature as an additional tool for surveys over areas difficult of surface access.

Although Americans cannot lay claim to the discovery of the applied science of geophysics, they quickly outdistanced all others in the extension of its use and in the improvement of its methods, instrumentation and accessory equipment. The American bent for organization and mechanization found full play in this new field, while the rapid growth of mining and petroleum operations afforded ample room for expanding activity. As a result most of the oil surveys carried on in the past dozen or fifteen years have been directed and conducted by American geophysical companies. Their crews are busy in all parts of the globe from Alaska to the Antarctic and from California to Celebes.

Not only have the professional operations of this branch of the oil industry grown tremendously, but geologists and geophysicists, by reason of their work and their knowledge of basic phases of oil search, have risen to positions of

high responsibility in private oil organizations and have become the trusted advisors of governments in their determination of oil policies.

Typical of progress made by geophysics as applied to petroleum and a noteworthy example of success in this expanding field is the story of a young man still in his forties and of the organization he founded and still directs. After schooling at Stanford University and Harvard and special training as an engineer, he established himself as a consultant in Pasadena, California, and organized the United Geophysical Company. His name is Herbert Hoover, Jr.

An exceptionally modest man, Mr. Hoover vigorously disclaims any special distinction for his company. It is just a working organization, he declares, which does its job wherever it may be to the best of its ability. This is unquestionably true, but it happens that many of the jobs have been in places far outside the United States and far distant from its home base. It happens also that through the combination of geological and geophysical expertness in the associated firm of Hoover, Curtice and Ruby, the members of that combination have in numerous cases been called as consultants in matters considerably removed from the immediate activities of either profession and have been retained by various governments to advise on petroleum laws and policies.

In its functional capacity United Geophysical has sixteen seismic crews at present operating in Wyoming, New Mexico, Texas, Oklahoma and California, the last including two water crews working off the coast at Santa Barbara. The seven gravity meter parties are divided between domestic and foreign work. At this time the company has crews working over the northernmost point of Alaska and the southernmost tip of Chile on the Straits of Magellan, which gives an idea of the worldwide coverage of the 16 foreign seismic crews.

Since geophysical exploration work is carried on over great distances and often in locations so isolated that the seismic crews are perhaps the first men even to set foot there, each party functions as an entity within itself. Every detail of equipment, instruments, food and shelter is planned beforehand and put in mobile form for exploring and mapping any given area.

Twelve men make up United basic crews working in the United States, there being six technical men and six helpers. Technical personnel include the party chief, surveyor, computer, operator, junior operator and mechanic. Foreign crews consist of a basic staff of eight technical personnel plus from 60 to 100 nationals, their number depending on the terrain of the country they are working. These helpers include chauffeurs, drill helpers, pica cutters, mechanics, rodmen, instrument bearers, "jug hustlers" carrying the seismometers, cooks, mess boys, camp bosses and cashiers.

Technical staff on all crews is made up of men with highly specialized training. The party chief, who acts as the seismologist, must have a technical background of mining engineering or geology and in addition executive ability to handle the varied business details of the party. The surveyor has a background of civil engineering; the computer has had seismological training; the operator has electrical engineering or radio background, and the mechanic is trained to take care of the mechanized equipment.

New mechanized additions to United's gray trucks and pickups are track-propelled "weasels" designed by the U. S. Army for covering difficult terrain. These are now used to great advantage in Alaska where they make fast headway over the miles of tundra. Also a semi-airborne project where a gravity meter is transported in light aircraft has been found to be highly successful as well as economical in Alaska. By this means an overall ground picture of the terrain can be obtained in one season, which with dependence on ground transportation might take years. The company has used a Piper Cub there with pontoon landing gear in the summer and ski landing gear when the ground is covered with snow, which is from September to May.

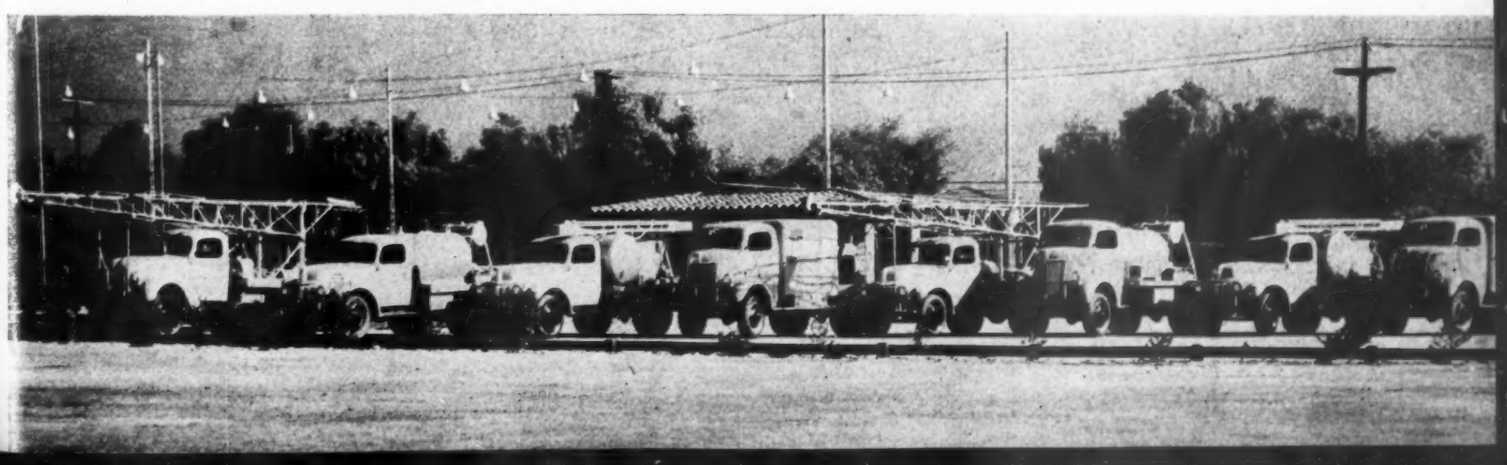
Helicopters have also been used by the company in semi-airborne gravity surveys. There are two limiting factors, however, to the use of helicopters on gravity surveys, which are the elevation of the project, as the lifting power of the helicopter decreases with elevation, as well as the high operational costs.

Working back of the crews in the field are the men in the home and supervisory offices: the field engineers who are available to both United States and foreign crews whenever needed, and the research laboratory which the company maintains where instruments and techniques are constantly being improved. A training program for those going out on foreign work is carried among the United States crews. Foreign supervisory offices are located in Fairbanks, Alaska; Bogota, Colombia; Caracas, Venezuela; Rio de Janeiro for the parties working in Brazil and Chile, and Beirut, Lebanon, for those in the Middle East.

Typical Venezuelan seismograph camp.

Field garage in Venezuela.

United Geophysical equipment now being operated for the Chilean government in the Magallanes. Shown are drill truck, water truck, shooting truck and recording truck.



MOTOR GASOLINE FROM MIDDLE EAST CRUDE[1]

By C. V. HILL,[2] H. T. LORNE[2] and A. R. MERCER[2]

FOR many years crude oil production from the Middle East has been assuming an increasing importance owing to the large reserves available and the rate at which production is being expanded. Thus, for the year 1947 the total production in this area was 307,762 thousand barrels, which was more than 15% of the total U. S. production.

These crude oils naturally form an important source of supply to Europe, Africa and Asia, and also to a limited extent are being imported into the U. S. It is felt, therefore, that a description of the products that may be obtained from them and the processes which can be applied to them will be of general interest. In particular, this paper is concerned with the production of motor gasoline, and, as a typical example of average Middle East crude, Iranian export crude has been selected.

Middle East crude oils are all substantially of the same characteristics, namely, wax bearing, mixed paraffinic/asphaltic base type. Iranian export crude as produced in the fields is stabilized by successive stages of separation and as shipped will contain small quantities of ethane and propane and a negligible content of hydrogen sulphide. A typical inspection is given in Table 1.

Table 1

Iranian Export Crude Inspection

Specific Gravity 60°F/60°F		0.853
A.P.I. Gravity	°A.P.I.	34.4
Reid Vapor Pressure	1 lbs.	7.0
Sulphur	% wt.	1.42
H_2S Content	% wt.	Nil
Hard Asphalt	% wt.	0.9
Ash Content	% wt.	0.02
Pour Point	F.	10°
Viscosity Kinematic	@ 70°F. C-stokes	8.8
"	@ 100°F. C-stokes	5.5

Straight run gasolines produced from Iranian crude are characterized by a relatively low octane number, and in general an appreciable sulphur content. However, the latter property varies in the Middle East Crudes and some gasolines are almost sulphur free. Due to the high paraffin hydrocarbon content, very high quality kerosenes and gas oils, and high pour-point but relatively low viscosity residues are also produced. The quality of the middle distillates is outstanding and it has been general practice to maintain the production of these grades at a maximum.

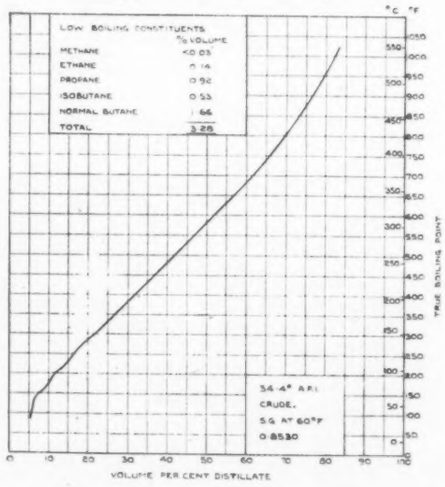
It may be interesting to turn to the average yields obtained from Iranian crude, and as a representative example we may refer to the product distribution from Abadan Refinery. Over the period 1945/47 the middle distillates amounted to 30% volume of the total products. Because Adadan is in a large fuel oil consuming area little or no residue cracking is undertaken, and the fuel oils formed 46% volume of the total products. As a result the motor gasoline production is much smaller than the product distribution of 50% in the U. S., and a world distribution of approximately 45% volume prior to the war. On the other hand, the fuel oil production is notably higher relative to world requirements, although at present the position is unusual in so far as there is a heavy demand for fuel oils, supplies being limited only by refining and tanker capacities. Present indications are that the demands for middle distillates (kerosene and diesel oils) will increase steadily in the foreseeable future and at least continue to keep in step with increased crude oil production.

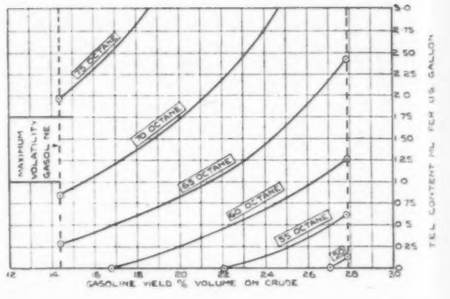
With these factors in mind the application of various refining schemes to Iranian crude has been studied. In all cases the middle distillates assume outstanding importance and in no case are these products processed in order to manufacture motor gasoline; the middle distillates have never formed to any extent the feed-stocks to cracking operations.

The processes applied to the straight run gasoline are sweetening and catalytic desulphurization. These may be taken as the extremes because the sweetening process is the simplest available, while catalytic desulphurization effects virtually complete sulphur removal with negligible loss in yield.

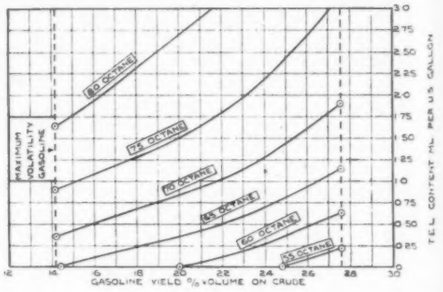
Where it is necessary to raise the quality of the S. R. gasolines above that obtained by the two processes just mentioned, naphtha upgrading processes are utilized. Thermal reforming, (with or without catalytic polymerization) and hydroforming, are typical examples.

True boiling point data for Iranian export crude.





Yield/Octane/T.E.L. relationships for sweetened Iranian S.R. gasolines.



Yield/Octane/T.E.L. relationships for desulfurized Iranian S.R. gasolines.

In order to readjust the product distribution obtained by straight distillation to one that compares with average world distribution under normal conditions, it is necessary to process residue for motor gasoline manufacture. Several methods are available but the most attractive one involves vacuum distillation to produce wax distillate (heavy gas oil) which is then processed by catalytic cracking. A further contribution may be made by catalytic polymerization of the cracked gases. By these means the motor gasoline production can be brought up to 40% of crude input and at the same time the quality is improved.

The simplest refinery scheme would be to distil motor gasoline and middle distillates from crude, the residue being fuel oil. Producing maximum gas oil the following cut points and yields of raw products are thought to be representative:

T. B. Position	Yield % Volume on Crude
Motor Gasoline Fraction to 375°F.	28.2
Middle Distillate Fractions 375-660°F.	28.6
Fuel Oil above 660°F.	41.9

If it is desired to manufacture maximum kerosene, it is necessary to reduce the end point of the motor gasoline. This procedure may be followed until the motor gasoline produced is too volatile for normal market requirements, or alternatively the kerosene is off specification for flash point. The kerosenes require sweetening, and by solvent extraction premium grade burning oils may be produced.

1) Paper presented to the Petroleum Division of the American Chemical Society, St. Louis, Mo., September, 1948. Here abridged.

2) Anglo-Iranian Oil Co., Ltd.

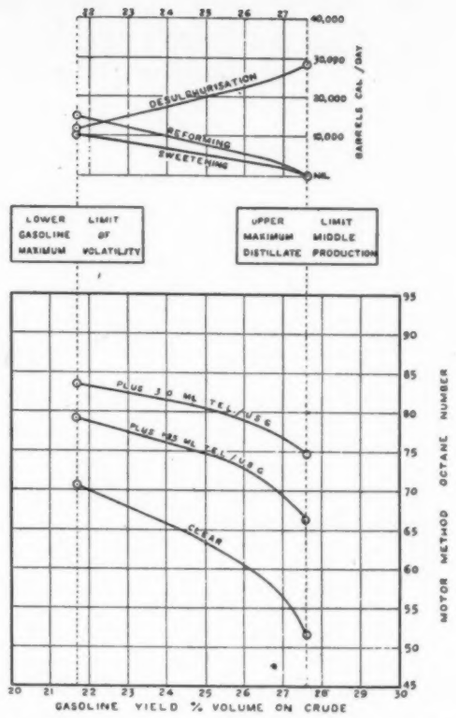
In passing, the following of the gas oil are given as typical:

	Making No. Kerosene	Making Maximum Kerosene
A.P.I.	37	35
Flash Point	160°F.	220°F.
Four Point	5°F.	20°F.
Sulphur	0.8% wt.	0.95% wt.
Diesel Index	60	56

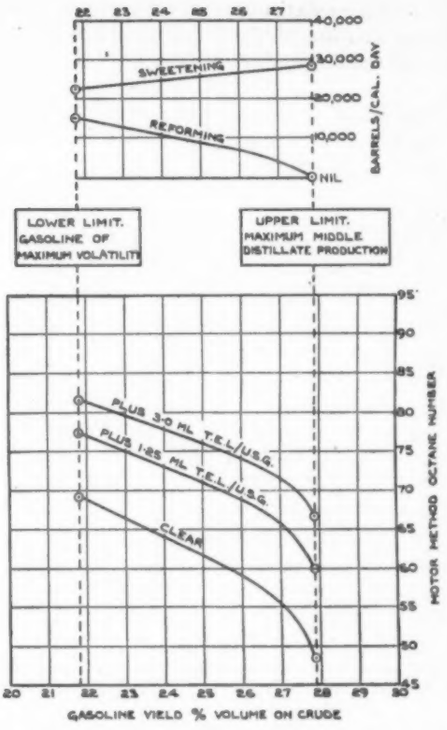
As previously remarked, the new gasolines produced from Iranian crude by straight distillation are characterized by a relatively low octane number and an appreciable sulphur and mercaptan content. In this paper the refining treatments studied have been confined to sweetening for doctor negativity and catalytic desulphurization. For the sweetening process the assumption has been made that there is no loss either of octane number or of lead response. A nominal process loss of 1% is assigned. Catalytic desulphurization based on pilot plant test data on Iranian distillates is assumed to give 90% reduction in sulphur and an increase of three octane numbers due to molecular re-arrangement. In this process a loss of 2% has been assigned as representative.

A number of cut points below 375°F. were selected, and the octane numbers calculated for the S. R. gasolines sweetened or catalytically desulphurized. The calculated values are all based upon actual determinations of the properties of gasoline produced in modern refinery equipment. The limiting cases for each process are summarized in Table 2, the limits being excessive volatility of low end point gasoline, and maximum T. B. P. cut points of 375°C. for conservation of middle distillate.

It will be seen that catalytic desulphurization has a very marked effect, particularly if the full 3.0 mls. TEL/U.S. gallon is permitted; the octane number of the full range gasoline increases from 48.5/60/66.5 to 51.5/66/75. As the table shows, these numbers refer to the Motor Method octane numbers clear, with 1.25 mls. TEL/U.S. gallon and with 3.0 mls. TEL/U.S. gallon. It will be noted that high octane leaded gasolines can be produced if the end point is dropped to the limit determined by volatility, but the yields are then little more than half the maximum yield of straight run gasoline.



Gasoline production from 100,000 B.P.C.D. Iranian crude employing reforming and catalytic desulfurization.



Gasoline production from 100,000 B.P.C.D. Iranian crude employing reforming and sweetening.

To utilize the S. R. gasoline to maximum advantage wtih least effect on the yields, a naphtha upgrading process is clearly indicated. As typical examples of available processes, thermal reforming and hydroforming have been selected for study, and the process data employed for these calculations are given in Table 3. The approach has been to use these processes to maximum advantage by tailoring the naphtha feed, and in what follows the plans required to obtain a given octane number is the theoretical minimum size. The effect of including catalytic polymerization of recovered C_3 and C_4 with thermal reforming is also illustrated.

The figures employed are average values for Iranian naphthas boiling between 300 and 400°F. Somewhat better yields might be expected when lower boiling feedstocks are employed. In each case the octane numbers quoted are about the maximum that can be obtained in continuous operation. The thermal reforming figures are based upon extensive full scale plant data available to Anglo-Iranian, and the hydro-

Table 2

Yields and Properties of S. R. Gasolines

Volatility Limit @ 158°F.	28% vol. max.	10% vol. min.
Specific Gravity @ 60°F.	0.695	0.727
" °A.P.I.	72.1	63.1
A.S.T.M. Distillation	°F. °C.	°F. °C.
10% vol.	130 or 54	156 or 69
50% vol.	190 or 88	257 or 125
90% vol.	250 or 121	347 or 175
F.B.P.	267 or 130	378 or 192
R.V.P. lbs.	10.8	7.7
Sweetened		
Yield % vol.	14.4	27.9
Sulphur % wt.	0.075	0.085
Octane Number (Motor)	62.2	48.5
" + 1.25 mls. TEL/USG.	72.2	59.9
" + 3.0 mls. TEL/USG.	78.1	66.7
Research/Motor Appreciation	0.5	0.5
Catalytically Desulphurised		
Yield % vol.	14.2	27.6
Sulphur % wt.	0.008	0.009
Octane Number (Motor)	65.2	51.5
" + 1.25 mls. TEL/USG.	77.5	66.1
" + 3.0 mls. TEL/USG.	84.8	74.8
Research/Motor Appreciation	0.5	0.5

Table 3

Average Process Data Used for Upgrading Heavy Nephtha

Process	Thermal Reforming	Hydro-forming
Refinery Yields % wt.		
Gas	12.7	12.4
C_3	(70% Rec.) 6.4	5.6
C_4	8.2 (90% Rec.)	(80% Rec.)
Gasoline (Debutanised)	63.5	78.0
Residue	9.2	2.5
Coke	—	1.5
C_3 Unsaturated %	38	—
C_4 Unsaturated %	57	—
Gasoline		
Treatment	Clay Treated	Nil
Loss % wt.	1	—
Gasoline % wt.	96	100
Residue % wt.	3	—
Finishing		
Treatment	Sweetened	Nil
Loss % wt.	1	—
Gasoline % wt.	99	100
Finished Gasoline Inspection		
S.G. @ 60°F.	0.745	0.7765
A.P.I. Gravity	58.4	50.8
Sulphur % wt.	0.05	0.001
R.V.P. lbs.	10	10
% Vol. @ 158°F.	15.5	12.5
% Vol. % 212°F.	30.5	30
F.B.P.	392	392
Octane (Motor)	74.0	79.1
Octane (Research)	82.0	85.4

forming predictions are based upon pilot plant data obtained in the Research Laboratories at Sunbury, England.

The introduction of a naphtha upgrading process has been illustrated in Table 4 for a hypothetical refinery processing 100,000 barrels of crude per calendar day. In each case starting from a fixed upper TBP cut points of 375°F. naphtha has been made progressively lighter until a point is reached at which the finished motor gasoline produced by blending straight run and reformed gasolines is too volatile by the standards already described. Thus in the reforming and sweetening case the limit is reached at 69/77/81.5 octane number when a quantity of 15,000 BPCD naphtha is reformed and the potential yield of 27.9% volume S. R. gasoline is reduced to 21.8% volume. Of course, still higher octane number finished gasolines could be produced by lengthening the naphtha into the kerosene/gas oil range. Alternatively, a part of the light gasoline could be included in the reformer charge stock. The former procedure has not been considered in this paper because of the demand for the middle distillates which does not make it desirable to consider them as possible feedstocks. The latter procedure is regarded as uneconomic as the octane improvement would be slight and the gas make excessive.

The yield/octane relationship for clear and leaded gasolines are given for the following combination of processes: Reforming and Sweetening; Reforming and Catalytic Desulphurization; Reforming and Catalytic Desulphurization plus Catalytic Polymerization; Hydroforming and Catalytic Desulphurization.

Table 4

Processing 100,000 B.P.C.D. Iranian Crude Yields and Properties of Motor Gasolines of Highest Octane Number Produced

Operations (Inputs)						
Reforming	BPCD.	15,000	15,000	15,000	15,000	Nil
Sweetening	BPCD.	22,000	22,000	10,000	10,000	Nil
Cat. Desulph.	BPCD.	Nil	Nil	12,000	12,000	10,800
Hydroforming	BPCD.	Nil	Nil	Nil	Nil	16,000
Cat. Poly.	BPCD.	Nil	3,000	Nil	3,000	Nil
Yields (% Volume Crude)		21.8	22.8	21.7	22.7	23.9
Properties						
Vol. % Distillate @ 158°F.		28	28	28	28	28
S. G. @ 60°F.		0.714	0.7145	0.714	0.7145	0.734
A.P.I. Gravity		66.7	66.6	66.7	66.6	61.2
A.S.T.M. Distillation		°F °C	°F °C	°F °C	°F °C	°F °C
10% vol.		124 = 51	124 = 51	124 = 51	124 = 51	126 = 52
50% vol.		196 = 91	197 = 92	194 = 90	196 = 91	201 = 94
90% vol.		313 = 156	317 = 158	311 = 155	313 = 156	332 = 167
F. B. P.		392 = 200	392 = 200	392 = 200	392 = 200	392 = 200
R. V. P.	lbs.	10	10	10	10	10
Sulphur	% wt.	0.064	0.061	0.028	0.027	0.005
Octane Number (Motor)		69.1	69.8	70.7	71.2	74.4
"	+ 1.25 mls. TEL/USG.	77.2	77.6	79.3	79.7	83.8
"	+ 3.0 mls. TEL/USG.	81.6	81.8	83.7	83.8	88.4
Octane Number (Research)		73.1	74.0	74.7	75.4	78.1
"	+ 1.25 mls. TEL/USG.	81.2	81.8	83.3	83.9	87.5
"	+ 3.0 mls. TEL/USG.	85.6	86.0	87.7	88.0	92.5
Research/Motor Octane Appreciation		4.0	4.2	4.0	4.2	3.7

Elimination of sweetening of S. R. gasoline in the hydroforming case has been deliberate, because the combination of sweet but high sulphur gasoline with hydroformate would lose the advantage obtained from the low sulphur content and good lead response of this material. The TEL responses of the blends have been calculated by means of Eastman charts as these have been found sufficiently accurate within the ranges considered.

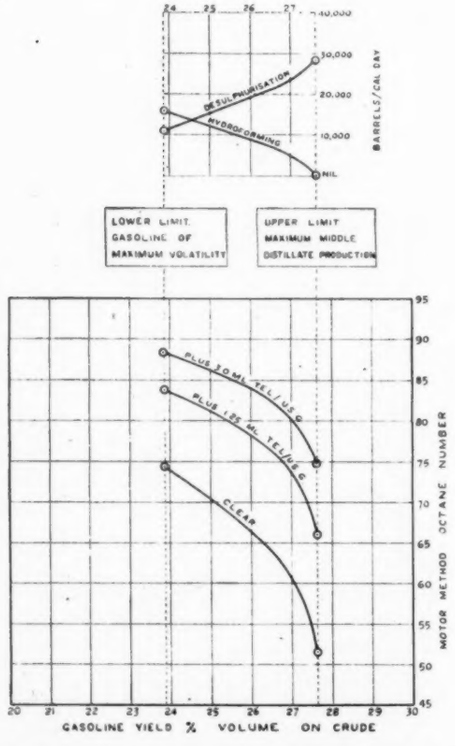
The correlations for unleaded gasolines show that each of the naphtha upgrading processes studied effects a marked improvement on the yield/octane relationship, with the hydroforming plus catalytic desulphurization route clearly the best. The inclusion of catalytic polymerization in the reforming cases has the effect of increasing the yield by about 1% volume on crude for the maximum reforming case and the octane number by about a half number.

In each of the cases selected, the maximum octane number obtainable has been limited by the volatility at 158°F. The results obtained at this limit are compared in Table 4, which gives also the plant capacity requirements, based on a crude input of 100,000 barrels per calendar day.

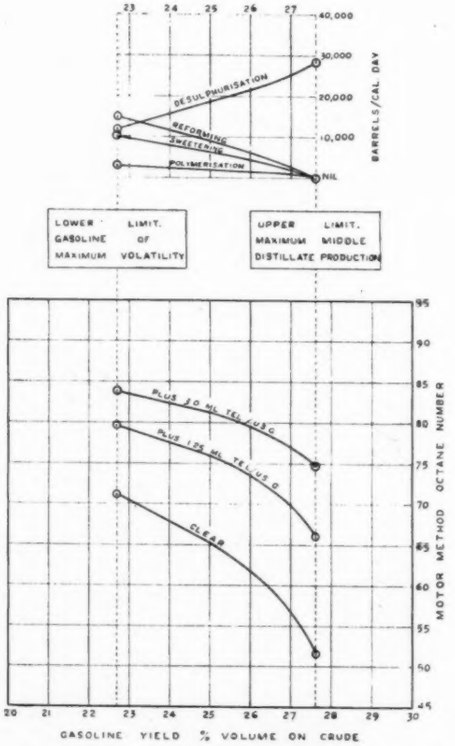
A feature of these results is the research/motor octane appreciation or "jump" of the finished gasolines. Table 4 also indicates that the research appreciation of hydroformate blends is somewhat lower than blends of reformed gasolines. Too much importance, however, should not be attached to this observation, as there are indications that hydroformate blends have excellent road performances.

As has been shown the maximum yield of S. R. gasoline that can be obtained from Iranian crude, when making maximum middle distillate, is 27.9% volume on crude. The naphtha upgrading processes reduce this yield, and in order to redress the position it is necessary to turn to processes for manufacturing gasoline from the fuel oil residue.

The residue boiling above gas oil (660°F. TBP cut point), obtained by distillation of Iranian crude is characterized by a high pour point and an appreciable sulphur content (see Table 7). It may be vacuum-distilled down to a 200 penetration asphalt, obtained in 16.6% volume on crude, the heavy gas oil (wax distillate) being a paraffinic wax bearing fraction well suited to the available cracking processes. In the past this wax distillate has been processed for fuel oil improvement, as by suitable thermal processes low viscosity low pour point fuel oils may be



Gasoline production from 100,000 B.P.C.D. Iranian crude employing reforming, catalytic desulfurization and catalytic polymerization.



Gasoline production from 100,000 B.P.D.C. Iranian crude employing hydroforming, and catalytic desulfurization.

Table 5

Catalytic Cracking Iranian Wax Distillate

Feedstock Inspection		
S. G. @ 60° F.	0.915	
A.P.I. Gravity	23.2	
10% volume @ °F.	665	
50% volume @ °F.	820	
90% volume @ °F.	1000	
Viscosity @ 210°F c. stokes	6.2	
Pour Point °F.	95	
Sulphur % wt.	1.65	
Predicted Yields		
(50% Conversion)	% weight	% volume on crude
Gas	3.9	—
C_3 (70% Recovery)	3.6	—
C_4 (90% Recovery)	7.0	—
Gasoline	30.8	9.7
Gas Oil	18.8	4.7
Waxy Residue	31.3	7.8
Coke	4.6	—
Total	100.0	
Catalytic Polymerisation		
Conversion C_3H_6	% 70	
Conversion C_4H_8	% 90	
Recovery of Polymer	% 90	

obtained. Cracked gasoline was produced in poor yield, had a low octane number, and on account of its high sulphur content, a poor lead response.

A much more attractive method of processing wax distillate for gasoline production is available today in the form of the catalytic cracking process. By this means good yields of high octance gasoline can be achieved, and the cracked gases, when catalytically polymerized, make a substantial contribution to motor gasoline production. Careful studies of this combination of processes indicate that with synthetic catalyst, approximately 50% conversion (D + L) is economically most attractive in the European field. With other catalysts, other conversions might be considered, and in certain circumstances recycling operations might be advantageous. For the purposes of this paper, however, a conversion of 50% volume has been selected as representative. Typical inspection data on the wax distillate feedstock and predicted yields at this conversion level are given in Table 5.

Simultaneously, with the production of a premium quality motor gasoline, the catalytic cracking process improves the fuel oil quality. The gas oil produced may be marketed as such or alternatively blended into catalytic cracker residues and asphalt. The fuel oil thus produced is illustrated in Table 6, which compares it with the residue above virgin gas oil. The inspection data show that the pour point is much improved, and the overall viscosity is reduced.

Table 6

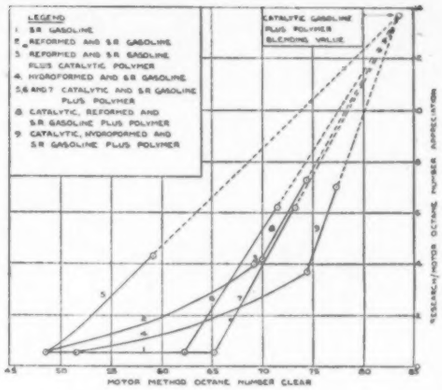
Yields and Properties of Fuel Oil Produced by Vacuum Flashing Iranian Residue and Catalytic Cracking the Wax Distillate

Fuel Oil	Iranian 41.9% Vol. Res.	Fuel Oil from Iranian residue by Cat. Cracking
Composition % volume		
Cracked Gas Oil	Nil	4.7
Wax distillate or Waxy Residues	25.3	7.8
Asphalt	16.6	16.6
Total Yield % volume on crude	41.9	29.1
Properties of Fuel Oil		
S. G. @ 60°F.	0.943	0.960
A. P. I. Gravity	18.5	15.9
Viscosity S. U. at 122°F.	940	795
A. S. T. M. pour point °F.	80	40
Sulphur % wt.	2.3	2.6

Motor gasoline produced by the catalytic cracking process is of premium grade quality. Typical inspection data are presented in Table 7 along with similar data for catalytic polymer and the blend of polymer and catalytic gasoline.

As will be seen the sulphur content is high, but the gasoline is doctor-negative and requires treatment only for gum stability and inhibitor response. The refining process employed is clay treatment. Acid treatment would be effective in

(Continued on page 76)


LEGEND
1 S.R. GASOLINE
2 REFORMED AND S.R. GASOLINE
3 REFORMED AND S.R. GASOLINE PLUS CATALYTIC POLYMER
4 HYDROFORMED AND S.R. GASOLINE
5,6 AND 7 CATALYTIC AND S.R. GASOLINE PLUS POLYMER
8 CATALYTIC, REFORMED AND S.R. GASOLINE PLUS POLYMER
9 CATALYTIC, HYDROFORMED AND S.R. GASOLINE PLUS POLYMER
CATALYTIC GASOLINE PLUS POLYMER BLENDING VALUE
RESEARCH/MOTOR OCTANE NUMBER APPRECIATION
MOTOR METHOD OCTANE NUMBER CLEAR

Research/motor octane relationships obtained by different combinations of processes.

Table 7

Processing 100,000 B.P.C.D. Iranian Crude Catalytic Cracking Heavy Gas Oil (Wax Distillate)

Catalytic Cracking Capacity BPCD.		10,000	17,000	25,000
Yield % vol. 10 lb R.V.P. Gasoline		3.79	6.43	9.46
" 10 lb. R.V.P. Cat. Poly.		0.73	1.25	1.83
" Total on Crude		4.52	7.68	11.29
Properties of Motor Gasoline		**Cat. Cracked**	**Cat. Poly.**	**Blend**
S. G. @ 60°F.		0.742	0.7225	0.739
A. P. I. Gravity		59.2	64.4	60.0
Sulphur	% wt.	0.16	0.001	0.135
R. V. P.	lbs.	10	10	10
Vol. %	@ 158°F.	29	18	27
Vol. %	@ 212°F.	50.5	29.5	47
F. B. P.	°F.	400	400	400
Octane Number (Motor)		80.9	84.6	81.5
"	+ 1.25 mls. TEL/USG.	83.0	86.6	83.6
"	+ 3.0 mls. TEL/USG.	84.2	87.6	84.8
Octane Number (Research)		95.2	95.6	95.2
"	+ 1.25 mls. TEL/USG.	97.3	97.6	97.3
"	+ 3.0 mls. TEL/USG.	98.5	98.6	98.5
Research Appreciation		14.3	11.0	13.7
Blending Octane Number (Motor)		80.9	95.6	83.3
"	+ 1.25 mls. TEL/USG.	83.0	97.6	85.4
"	+ 3.0 mls. TEL/USG.	84.2	98.6	86.5
" Clear (Research)		95.2	106.6	97.0

Table 8

Processing 100,000 B.P.C.D. Iranian Crude Motor Gasolines Produced by Blending S. R. Gasolines and Catalytic Cracked Gasolines

S.R. Gasoline Treatment	Sweetening Maximum (25% Crude)		Catalytic Desulph. Maximum (25% Crude)	
Catalytic Cracking	Maximum Yield	Maximum Volatility	Maximum Yield	Maximum Volatility
Limit				
Composition (% volume)				
S. R. Casoline	28.4	14.3	28.1	14.0
Cat. Cracked	9.5	9.5	9.5	9.5
Cat. Polymer	1.8	1.8	1.8	1.8
Total Yield (% volume on crude)	39.7	25.6	39.4	25.3
Properties				
S. G. @ 60°F.	0.7285	0.7145	0.7285	0.7145
" °A. P. I.	62.7	66.6	62.7	66.6
A. S. T. M. Distillation	°F. °C.	°F. °C.	°F. °C.	°F. °C.
10% vol.	144 = 63	122 = 50	144 = 63	122 = 50
50% vol.	244 = 118	192 = 89	244 = 118	192 = 89
90% vol.	352 = 178	336 = 170	352 = 178	336 = 170
F. B. P.	400 = 204	400 = 204	400 = 204	400 = 204
R. V. P. lbs.	9.2	10.0	9.2	10.0
Sulphur % wt.	0.10	0.10	0.05	0.07
Octane Number (Motor)	59.1	71.5	61.2	73.2
" + 1.25 mls. TEL/USG.	67.8	78.0	72.3	81.0
" + 3.0 mls. TEL/USG.	72.8	81.8	78.8	85.7
Octane Number (Research)	63.4	77.7	65.5	79.4
" + 1.25 mls. TEL/USG.	72.1	84.2	76.6	87.2
" + 3.0 mls. TEL/USG.	77.1	88.0	83.1	91.9
Research/Motor Appreciation	4.3	6.2	4.3	6.2

YUGOSLAV FIVE-YEAR OIL PLAN

By E. A. Bell

NATIONALIZATION of oil as of most industries in Yugoslavia was followed by the setting up of a five-year plan (1947-51) for development of the country's petroleum resources. In government circles the prospects of increased production as a result of this program are viewed optimistically. It is stated that the areas in the Lendava district of northwestern Yugoslavia near the three-cornered frontier between Austria, Hungary and Yugoslavia will be intensively prospected.

In this district Mursko Srdiste has been known as the center of the oil zone since 1920, when Medjimursko Petrolejstvo Drustvo (Medkimursko Oil Co., so named after the Medjimurje region, a part of the Lendava oil zone,) became active in prospecting and drilling. It was a venture launched by the First Croatian Savings Bank of Zagreb. At a later stage the Medjimursko Oil Co. passed under the control of the Swiss Holdinhand Company. It incurred losses in 1938 and 1939 amounting to Dinar 2,600,000 for each of the two years, as compared with the company's share capital of Dinar 2,500,000. The share capital was increased subsequently to Dinar 12,500,000 subdivided into 100,000 new shares. Out of these, the Yugoslav government received 25,000 shares free. Late in 1940 it became known that the Swiss holding company had dissociated itself from the Medkimursko Company, the latter having come under the control of the Italian AGIP concern (Azienda Generale Italiana Petroli). For a time the new Yugoslav-Italian AGIP subsidiary was headed by Signor Cobolli-Gigli assisted by a number of Italian industrialists.

Before the war the Lendava district had been Yugoslavia's only area producing crude oil in commercial quantities. The main wells were then those near Paklenica and Selnica. The Lendava field yielded roundly 6,700 barrels of crude in 1938 when the entire production of mineral oil in Yugoslavia totaled a little over 8,000 barrels valued at Dinar 1,288,000, of which the Lendava output accounted for Dinar 1,054,000. Small though the output of crude had been in that year, it was approximately double the total obtained in 1937 in the Lendava field and other areas, mainly near Sarajevo.

Chief among the other areas is the Goilo field, located to the north of the Sava river and to the west of its tributary Pakra. Its southern edge extends to Kutina, 49 miles to the southwest of Zagreb, on the Zagreb-Belgrade railway line. It extends north into the Moslavacka mountain range, sloping along the Goilo mountain from which it takes its name. To the west is Mikleuska village, lying a few miles northwest of Kutina. This area is regarded at present as Yugoslavia's most promising oil district, though there are others which are considered in a favorable light. These extend from the Goilo field toward the north and northwest in the direction

Oil map of Yugoslovia

of the Lendava district, partly skirting the Hungarian frontier. Near Veliki Poganac and Sokolovac for instance oil has been located. Sokolovac is seven and a half miles to the southwest of Koprivnica, a town to the northeast of Zagreb on the railway line skirting the Hungarian border. Veliki Poganac is in the neighborhood of the Kalnik mountain range in the east. Some twelve and a half miles further northwest of Koprivnica near Lubreg village, another oil-bearing zone has been located, and others have been found near Velika Gorica southeast of Zagreb and near Dugoselo, thirteen miles to the east. Oil prospecting extending some fifteen miles to the east of Dugoselo has been successful near Casma village, and thence further north near Krizveci, some eleven miles to the south of Sokolovac, the village mentioned above.

Farther afield Daruvar, a town to the northeast of Kutina, is known as a center of various oil prospects, including one near Uljanik, halfway between Daruvar and Kutina. The latter has some productive wells of natural gas. Some fourteen miles to the south of Daruvar is Pakrac and just south of the latter, Lipik, a health resort known for its hot springs, in the neighborhood of which oil has been located. Then to the southeast along the foothills of the Papuk mountain range, oil has been spotted near Cernik village north of Nova Gradiska. Indications have been found further east in the same mountain region near Pozega and extending southeast near Slavonski Brod where the Sava river forms the frontier with Bosnia. Fifty miles to the northeast of Slavonski Brod, Osijek town, near the point where the Drava river joins the Danube, marks another oil-bearing region with promising wells near Aljmas village, near Erdut on the Danube east of Aljmas, and near Bijelo Brdo, north of Osijek.

While all these places are to the north of the Sava river, oil strata have been located also in various regions south of it near Sisak and near Petrinja southwest of Sisak. Considerably further south on Bosnia's western frontier near the town of Bihac, oil was discovered near Zavalje and near Korenica, some eight miles to the west of Zavalje.

While the deposits so far mentioned are all located in Croatia, adjacent Bosnia and Serbia include certain oil areas, some of which were worked before the war. In Bosnia, the most important is near Kakanj, approximately thirty miles to the northwest of Sarajevo near the Bosna valley, but there are a few others in the northeastern corner of the country in the lower slopes of the Mejevica mountain range near Razanj and Zavid, near the town of Tuzla which is known for its salt wells. Prospecting in the vicinity of these two places first took place in 1937.

In Serbia oil has been located near Kladovo on the bend of the Danube near the Bulgarian frontier, and further south near Negotin close to the Bulgarian frontier. Still further south in the neighborhood of Nish on the Belgrade-Sofia main railway line, oil findings were made near Aleksinac and Soko, two mineral watering places to the northwest of Nish.

While a number of these oil zones may in the end prove of minor commercial value, hopes are centered mainly on the Goilo and Lendava regions, and development there will first be undertaken.

Considerable effort, both technical and financial, will be required if the final target of 3,500,000 barrels of crude oil for 1951 set by the five-year plan is to be attained. The total represents an increase of some 45,000 percent over the 1939 total of roundly 7,000 barrels. With this program in view, however, all known oil areas are to be explored and tested, including the bituminous shale deposits located mainly in the vicinity of Zagreb.

Concurrently the refining capacity available in Yugoslavia is to be increased by a new refinery including a cracking unit and having a throughput of 2,500,000 barrels per year. Location of the refinery has not been announced, but it is to be completed by 1950, according to the plan. In the meantime the Yugoslav refining industry comprises the following refineries: at Osijek, formerly owned by the British Phoenix oil concern; at Bosanski Brod on the southern bank of the Sava river, opposite to Slavonski Brod, formerly owned by Standard Oil Co. (N. J.); a refinery at Sisak formerly owned by the Royal Dutch-Shell Group. Finally there is a refinery at Rijeka, formerly Fiume; once owned by the Italian Romsa concern (Raffineria Olii Minerali Societe Anonima). This refinery, with a yearly capacity of around 850,000 barrels, came under Yugoslav control because Rijeka is located in the territory ceded to Yugoslavia by Italy as a result of the war. The refineries at Osijek and Bosanski Brod were reported "totally destroyed by air bombardment" during the war, but it is believed that they have been rebuilt since. The latter refinery and that at Sisak total a throughput capacity of about 1,500,000 barrels per year. Extensive oil storage plants at Smederevo on the southern bank of the Danube, some fifty miles east of Belgrade, suffered repeated air raids during the war. Those storage plants were erected in connection with the trans-shipmnt of oil products from Romania from smaller tankers capable of navigating the stretch of the Danube between Orsova on the Romanian frontier, where the "Iron Gates" begin, and Smederevo where the rapids and narrows known as "Derdap" end, into larger tankers for conveyance further upstream.

The Five-Year Plan mentions only gasoline as a refining product, with a proposed output of 550,000 barrels, including 150,000 barrels of synthetic gasoline for the year 1951.

Expansion in the country's oil economy and the enhanced availability to consumers of oil derivatives is also contemplated in the plan totals referring to transport. Whereas railway tank wagons in 1938 totaled 688 units, the plan envisages for 1951 a total of 2,400 tank wagons, an increase of 349 percent over 1938.

A weighty factor in the envisaged increase in the country's consumption of oil derivatives is the large-scale mechanization of agriculture which is to take place in the five-year period. The number of 15-hp tractors, to quote but one item, is to be increased from 3,990 in 1939 to 4,500 in 1951. The expanding number of road motor vehicles will add greatly to the consumption of oil products. In this respect it may be mentioned that there were 2,195 lorries in Yugoslavia in 1946. The plan looks to a total of 4,135 by 1951. The number of buses, 518 in 1946, is to be 1,205 in 1951, while the number of taxis is to be increased from 632 to 1,065 in the same lapse of time. Air transport, too, is to consume more oil products, since inland air services are to cover 2,814,060 miles in 1951, as compared with only 100,697 miles in 1946.

Industry will absorb larger quantities of oil products as a result of the intense industrial drive now in progress. On the other hand, less kerosene will be consumed, owing to the country's electrification, kerosene being still widely used in out-of-the-way regions for lighting purposes. To give an idea of the proposed electrification it is proposed that the output of electric power be increased 4,350 million kwh by 1951 as against 1,100 million kwh in 1939.

Yugoslavia's imports in the years immediately before the war were at the rate of about a million barrels of crude and 125,000 to 150,000 barrels of products annually.

Within the framework of the nationalization law of December, 1946, the country's oil industry passed under state control from production down to retail selling. Imports, too, are state-handled. The organizations dealing with the entire range of oil activities are "Jugopetrol," a wholly state-owned concern with headquarters at Belgrade, and "Jugonafta," the latter dealing also with the production, distribution and retailing of natural gas obtained near Kutina. "Jugopetrol" maintains regional offices at Zagreb, Ljubljana, Sarajevo, Lotor, Novi Sad, Split, Rijeka and Skopje. In Macedonia the business is handled from Skopje, its capital, by a special trading and retailing organization, also state-owned, known as "Glavnata direkcija no drzavnite trgovski stovarista i narodni magazini vo Makedonija."

No figures in regard to actual results as to oil and its derivatives have been made available so far for 1947, the first year of the plan, though an announcement published at Moscow in August, 1947, pointed out that the target of the Yogoslav oil and natural gas industry for the first half of 1947 had been fulfilled to 118 percent. It is believed that this referred to both production and refining. Nothing has transpired regarding imports, but Albania has been credited with having plaved an important part in this connection owing to the activities of a mixed Albano-Yugoslav oil company at Tirana which controls the Albanian oilfields, formerly Italian-controlled, near Devoli and in other zones. Their prewar output totaled something like 2,200,000 barrels of crude per year.

ROCKETS AND RAMJETS

FACTORS IN THE POWER PLANT REVOLUTION IN AIRCRAFT

By ERIC ELTHAM

This is the third and concluding article by Mr. Eltham dealing with the current basic changes in power plants and fuels employed in the aircraft industry. Previous articles of the series were published in the July and August issues of World Petroleum—Editor.

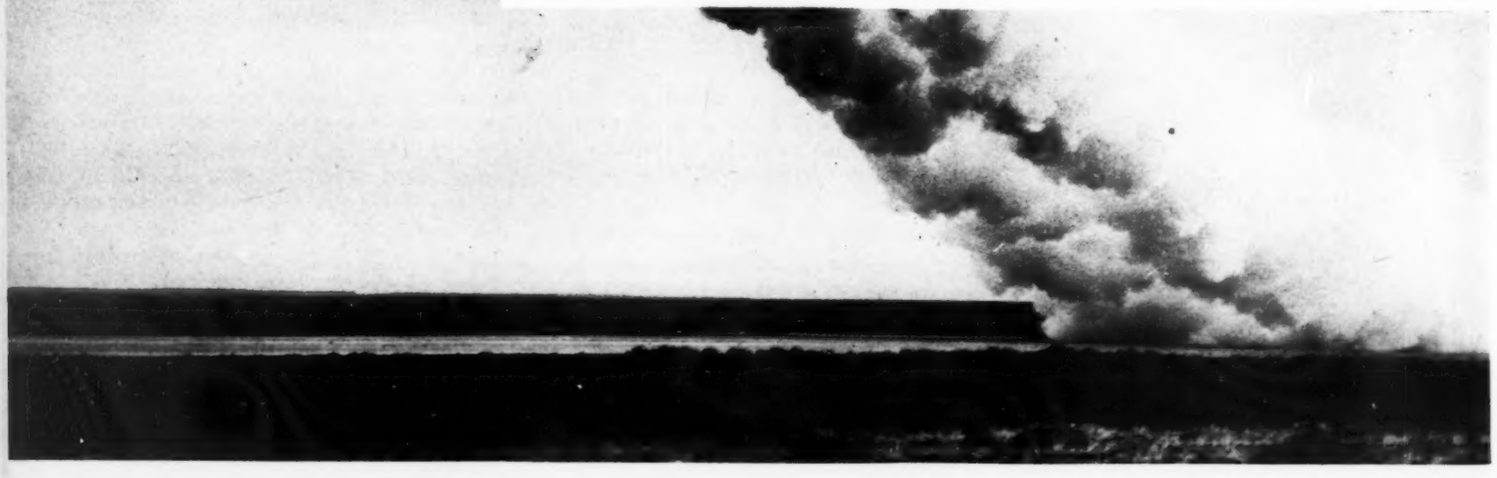
ROCKET propulsion for aircraft is not something to be left to the comic strip artists and interplanetary flight visionaries. It is being used today not only in experimental aircraft but in cargo carrying planes of the commercial airlines. What was once an art practiced for pyrotechnic purposes is now a highly technical industry employing some of the best brains in both industry and our universities. The use of this form of propulsion will continue to grow, and this growth will be watched by the petroleum industry which has a large stake in the fuels that will be used.

Rockets are important for two reasons. First, they can deliver large amounts of power almost instantaneously. This property is being used at the present moment to push experimental planes through the sonic barrier, and to launch fighter planes from the deck of aircraft carriers. Secondly, they are the only form of power plant that will function in the upper atmosphere or in interplanetary space where there is no atmosphere at all. Ordinary engines depend upon the oxygen in the air to burn their fuel, but the rocket always carries its own supply of oxygen with it, either in the form of liquid oxygen or, in the solid fuel rocket, in the form of a chemical compound like potassium perchlorate.

Rockets are generally classified as being liquid fuel or solid fuel type, depending upon whether the fuel is a liquid like gasoline and oxygen (also known as the bipropellant type) or a solid like the powder mixture used in a Fourth of July skyrocket. The solid fuel type of rocket has been known for a thousand or more years and was probably invented by the Chinese. For centuries it had been used as a toy and it was not until 1941 that a rocket was put to practical use. In August of that year workers at the Jet Propulsion Laboratory of the California Institute of Technology attached six small rockets to an Ercoupe light plane and demonstrated the effectiveness of this form of propulsion in assisting the plane to take-off with heavy loads. This demonstration was the result of two years' work directed by Dr. Theodor von Kármán and Dr. Fritz Zwicky, and was known as GALCIT, an abbreviation for Guggeheim Aeronautical Laboratory, California Institute of Technology. In 1942 the AeroJet Engineering Company was formed to manufacture the rockets developed by GALCIT, and in 1915 AeroJet became a subsidiary of the General Tire and Rubber Company. By the end of the war AeroJet was turning out 1000 JATO (Jet assisted take-off) rocket motors a day.

Rocket research in America had been going on for a number of years prior to this under the auspices of the Rocket Society of America. This Society is an affiliate of the American Society of Mechanical Engineers and is devoted to the encouragement of scientific research and engineering development of jet-propulsion devices and their application to problems of transportation and communication. The leading spirit of this little group of experimenters was Dr. Robert H. Goddard who carried on continuous research on rocket propulsion from 1920 to 1945. For years he was regarded as a crackpot who wanted to make Jules Verne voyages to the moon and his

Photo copyright 1948 by Boeing Airplane Co., Seattle, Washington.

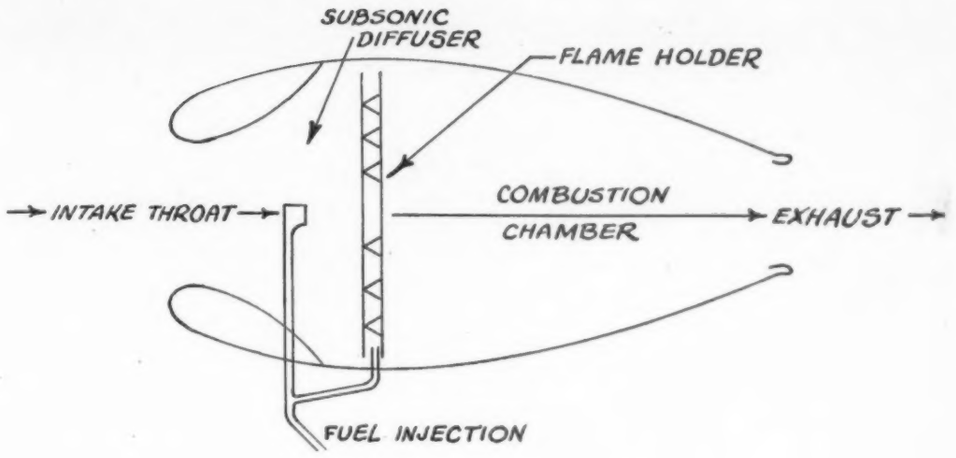


efforts led to skirmishes with the local authorities who objected to his shooting projectiles into their skies. The Society was often forced to make most elaborate plans to carry out its tests in secrecy, and immediately upon completing a test the members would scatter in all directions so as to make it difficult for the police to apprehend them. Fortunately, the Guggenheims became interested in Goddard's work and the Guggenheim Foundation made it possible for him to carry on in New Mexico. The genius of Dr. Goddard can be appreciated by examining one of his advanced liquid propelled rockets. On a small scale it is the V-2 which was used so effectively by the Germans during the war, and it is obvious that the Germans paid much more attention to Dr. Goddard's work than his own countrymen who were too ready to regard him as an eccentric inventor. The patents he took out on rocket systems are the basis of rocketry, and they have recently been acquired by one of our largest aircraft companies.

Each type of rocket has its own particular application. The solid fuel type produces extremely large thrusts in a very short interval of time and it is not susceptible to control. For this reason it seems best adapted to assisting conventional type aircraft when extra power is needed as in take-off. The liquid propellant rocket is used when control over thrust is desired, and this type of rocket is being used in experimental aircraft like the Douglas Skyrocket.

The JATO Unit is the solid type rocket used on commercial and fighter aircraft to assist them in taking-off, and it is the rocket engine used on the Boeing XB-47 bomber to obtain extra thrust. The usual JATO unit is a spun seamless steel cylinder about ten inches in diameter and three feet long. It is filled with a propellant mixture usually solidified with asphalt. On the after end are a nozzle, igniting mechanism and a safety blowout device. Because of the terrific heat and velocity of the gases given off when the rocket is fired, a carbon insert is placed in the nozzle throat. From the time the pilot closes the igniter circuit until the rocket motor develops 80% its rated thrust of 1,000 lbs. is 2/10 to 5/10 of a second. The duration of the thrust is only twelve seconds, but this is enough to reduce the take-off distance of a twin engine aircraft by 40 percent or increase the payload by 2,000 lbs.

The liquid fuel rocket is the rocket that will be used on passenger carrying aircraft, and which is already being used by the Army & Navy in the experimental Skystreak and in the XS-1, the Navy plane that has flown faster than the speed of sound. The fuel system is made up of two separate sets of storage chambers, one set being used for the fuel and the other for the oxidizing agent which is usually liquid oxygen. Fuel and oxygen are fed, under pressure to the mixing nozzles in the combustion chamber where ignition takes place. Here temperatures as high as 6,300°F. are reached and careful attention must be given to combustion chamber materials that will withstand these temperatures. The pressure in the chamber is also high, being in the neighborhood of 500 psi and at the exit the velocity of the gases may be 8,000 feet per second. In order to prevent failure of the rocket as a result of burning, melting or erosion, the chamber is cooled either by fins or by the incoming fuel which circulates around the chamber before entering the injection nozzle.



The problem of getting the fuel into the combustion chamber has been one of the most difficult to solve, for it is essential that the oxygen and air come together in the combustion chamber in the right proportions. Since the oxygen is always under pressure, this part of the system presents no trouble at all, but the fuel has to be delivered either by nitrogen pressure or by pumping. The nitrogen system has been the most widely used, but it is far from satisfactory and the weight of the nitrogen cylinder reduces the payload. The first model of the XS-1 used a pressurized fuel system and could only operate for 2.5 minutes at full 6,000 lbs. thrust. Later versions will use turbo fuel pump, which will meter the fuel more accurately and as a result the operating time will be almost doubled. At the same time, because of the elimination of the weight of the nitrogen cylinder, speed will be greatly increased.

A rocket develops thrust by giving a very high velocity to a small mass of gas. This gas is formed by the burning of the fuel in the combustion chamber. When it is remembered a rocket must not only carry its own fuel supply, like any vehicle, but its oxygen requirements as well, it is apparent that the efficiency of the fuel-oxidizer combination must be very high. A measure of this efficiency is given by the specific impulse of the combination, which is another way of saying the merit of a fuel is the pounds of thrust it will give per pound of propellant (fuel plus oxidizer) consumed per second.

Comparison of Various Rocket Fuel Combinations

System (Wt. %)	Density (gm/cc)	Chamber Pressure (Atm.)	Chamber Temperature (°R)	Specific Impulse (Secs.)
20% Liquid Hydrogen 80% Liquid Oxygen	0.284	23.0	5,500	350
60% Anhydrous Hydrazine 40% Liquid Oxygen	1.060	20.4	5,550	265
40% Ethyl Alcohol 60% Liquid Oxygen	0.966	20.4	5,720	243
28.5% Gasoline 71.5% Liquid Oxygen	0.978	20.4	5,930	242
18% Monoethylaniline 82% Mixed Acid	1.396	23.0	5,060	210

Another factor entering into the choice of rocket propellants is their density. A high density is advantageous, for it is necessary to pack as many BTU's per unit volume as possible into the space-limited rocket. Also considered desirable is a low heat of formation, for the heat necessary to break the compound down into its elements must be subtracted from the total heat of combustion.

From the following table, prepared by E. L. Klein, of the Bureau of Aeronautics, it is seen that an ideal propellant is the combination of hydrogen and oxygen, for it has the highest specific impulse of all the combinations listed Unfortunately low density of liquid hydrogen, 4.4 lbs. per cubic foot, offsets the advantage of the specific impulse. Gasoline and oxygen, it will be noted has a specific impulse only two-thirds that of hydrogen and oxygen. This is because the gasoline is 85% carbon, and carbon has a very low specific impulse. On the other hand, this combination has a more favorable density characteristic.

Taking all these factors into consideration, we find that hydrozine or organic amines (hydrocarbons containing amino groups) are the most promising fuels for bi-propellant systems. Since these compounds are available from petroleum there is little doubt that the industry will be in the rocket fuel business sooner or later. Alcohol is another petroleum derivative which has long been used as a rocket fuel, and from a safety point of view it is still one of the best. Some consideration has been given to using finely divided magnesium or aluminum as rocket fuels, and while these materials have high heats of combustion they have several disadvantages, not the least of which is availability. Petroleum is the only readily available source of fuels in large quantities.

One may ask with good deal of reason what is the use of a power plant that can operate at the

Take-off of P-80. Photograph courtesy Aerojet Engineering Corp., Azusa, Calif.

most for only a few minutes? The answer is that in many instances bursts of power are only needed for very short intervals. For example, if a plane is taking off under its own power and one of the engines fails it may be too late to stop it on the runway and yet it may not be able to clear an obstacle in its path. Firing of a rocket would ensure that the plane was safely airborne, and once in the air it could return to its base with its remaining engines. To push a plane beyond the speed of sound requires excessive power. Once beyond this critical speed, only normal power requirements are believed to be necessary. Rockets are the obvious power plant for pushing aircraft beyond the sonic barrier.

Furthermore, rockets appear to be the best method of escaping from the gravitational field of the earth. The advisability of sending space ships into interplanetary space may be debatable, but there is no doubt we shall do this if only for the purpose of collecting data on cosmic rays. When a missile is once beyond the pull of gravity, it will remain in motion in a given direction until some other force, as for example the gravitational effect of some other heavenly body, causes it to change direction. Thus, continuous power is not necessary to keep the missile in motion, and rockets will be used only for purposes of acceleration and for keeping the missile on its course.

While the concept of rocket propulsion dates back probably a thousand years or more, the ramjet or athodyd principle is scarcely twenty years old. This engine in appearance is simplicity itself, having not a single moving part. Externally it resembles the turbojet, but inside it is nothing more than a hollow piece of stovepipe with slightly streamlined contours. When the ramjet is moving rapidly, air is forced in at the front where it is naturally compressed by the impact of the air following it. Near the point where the air is most highly compressed fuel is added, and the heat of combustion forces a jet of hot, high velocity gases out the rear. Essentially, therefore, it is a gas turbine without the complications of a compressor, starter, accessory gears, lubricating pump, or the turbine!

Such simplicity would seem to be the answer to an engineer's dream. The ratio of thrust to unit weight is very high, and the problem of the design of turbine blades to resist high temperatures (the most serious problem facing the designers of gas turbine) is absent. What, then, are the reasons the ramjet is not more widely used?

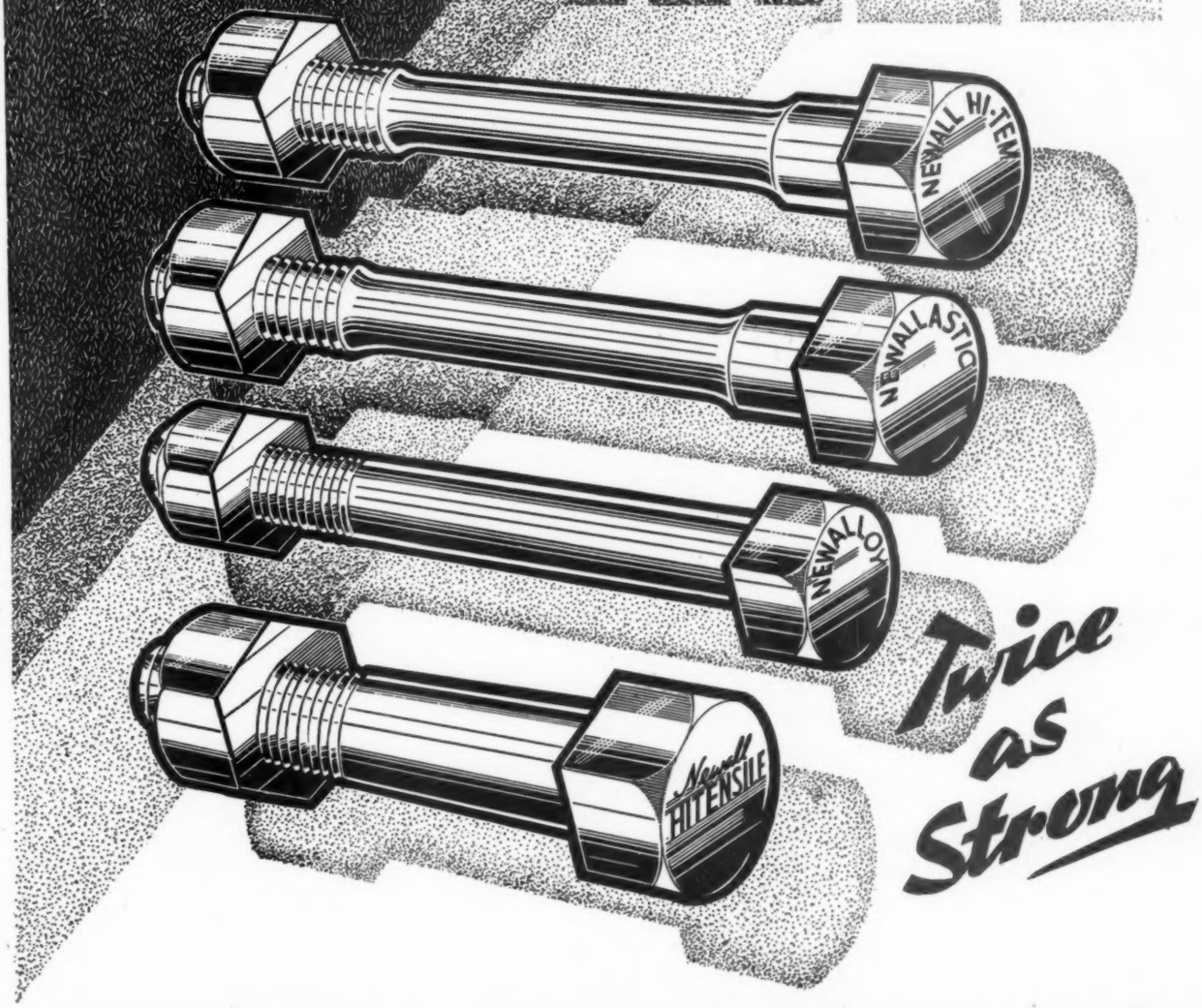
The primary reason is probably our unfamiliarity with the principles governing the design of ramjets. At present they have prodigious appetites for fuel, consuming about 3.5 lbs. of fuel per hour for every pound of thrust delivered, compared with 1.1 for gas turbines. This would be in the neighborhood of 3500 gallons an hour for a bomber with four ramjets developing a total of 12-15,000 lbs. of thrust. It is conceivable that we can reduce this figure as we learn more about combustion in a ramjet, and as the velocity increases the specific fuel consumption drops. It is for this reason that experts at the National Advisory Committee for Aeronautics feel that the ramjet may be the answer for speeds beyond that of sound. The most serious disadvantage inherent in the ramjet is the fact that it is not self-starting. Rockets are usually used to give the ramjet a velocity of about 1200 feet per second, the velocity at which combustion becomes self-sustaining. That this is not impractical can be seen by the photograph of the Boeing XB-47 turbojet bomber taking off with the assistance of eighteen rockets.

The United States Air Force and the Navy are doing extensive work on ramjets, particularly as powerplants for guided missiles. Various private companies are also enthusiastic about the future of ramjets, notably the Marquardt Aircraft Company, manufacturers of ramjets, and the McDonnell Aircraft Corporation who have designed and flown "Little Henry," a passenger carrying, ramjet powered helicopter. This latter application is probably the most promising, for ramjets on the blade tips of helicopters do away with complicated transmissions and the torque in the rotating shaft.

When it comes to fuels, ramjets are very catholic in their tastes. Hydrocarbon fuels are usually used, with ordinary low octane aviation gasoline or motor gasoline giving the good results. However, as speeds increase volatility problems may enter the picture. This is because the heat generated by the friction of the air becomes a serious factor, reaching as much as 1,200°F. at speeds four times those of sound. It is quite conceivable that high viscosity, high end-point fuels would be necessary under such conditions.

This remarkable photograph was taken at a speed of 1/200,000 of a second in the Thornton, England, fuel research laboratories of the Shell companies. The camera was specially designed for laboratory use to show the spray pattern from a gas turbine fuel injection nozzle.

NEWALL



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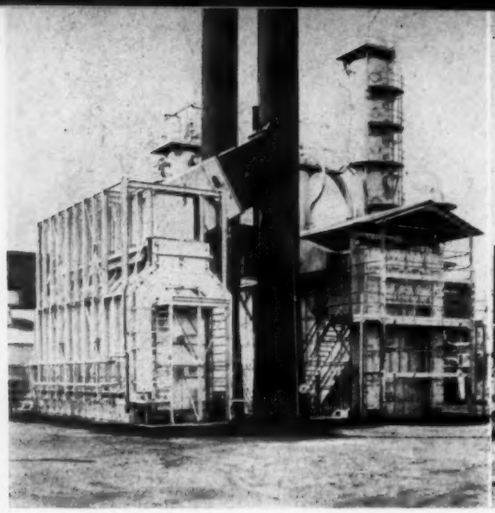
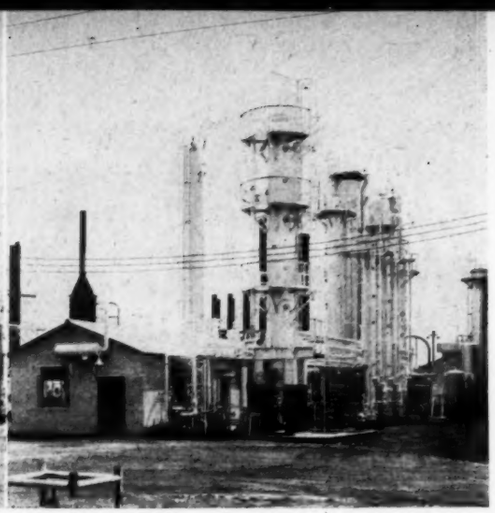
McMurrey Adds Polymerization Unit

By O. C. DeLoach*



Heaters for UOP thermal cracking unit.



Stabilizer and UOP polymerization unit.

LATEST step in a program of expansion and improvement at the plant of McMurrey Refining Company, Tyler, Texas, is the installation of a UOP catalytic polymerization unit.

The unit, which is of the calendar type, with a single tower and multiple catalyst beds, was designed by UOP engineers and built by McMurrey's own construction department.

Charge stock to the unit is the net stabilizer gas from the UOP thermal cracking unit. Its composition and that of the polymer product leaving the poly plant are shown in the following table:

	Fresh Feed Gas Mol. %	Polymer Gasoline Liquid Vol. %
Hydrogen		
Methane	1.8	
Ethylene	1.8	
Ethane	7.6	
Propylene	14.1	
Propane	24.5	
Isobutane	3.5	0.4
Isobutylene	7.2	0.1
n-butylene	15.2	2.5
Normal butane	22.4	13.9
Pentanes	1.9	9.2
Hexanes plus		73.9
	100.0	100.0
Specific gravity of hexanes plus		0.7316

Properties of Polymer Gasoline

End Point, °F.	396
RVP, pounds	12.3
Specific gravity	.7082

The poly unit has been in continuous operation since it was placed on stream, producing approximately 150 barrels of polymer per day which represents about four percent on the topped crude charged to the cracking unit and an eight percent increase in gasoline yield.

Not only is the overall production of gasoline thus increased, but the addition of the high octane polymer to the motor fuel considerably reduces the amount of tetraethyl lead required to maintain the octane standard at 80 ASTM and 88 Research for premium gasoline, thereby effecting substantial savings. The polymer has an 82.5 ASTM octane rating and 100 ASTM blending value. Up to August 15 the yield of polymer has been 66 gallons per pound of catalyst and the condition of the catalyst at that time was such as to indicate considerably longer effective life. Olefin conversion rate is about ninety percent.

A number of catalytic polymerization units have been installed in various refineries since the war to process gases from catalytic cracking units. Many of these have been built by the adaptation of existing equipment. By contrast, this unit, designed to polymerize thermally cracked gases, has been built with all new material from the ground up, in accordance with the company's policy.

In operation, the gas from the cracking plant stabilizer is caustic washed and water washed. It is then picked up by a compressor and passes through the catalyst tower after exchanging heat with the catalyst tower effluent and being further heated to reaction temperature by means of a hot oil exchanger. Liquid butane is employed as a quench for catalyst temperature control. The catalyst tower effluent is fractionated to produce a stabilized polymer and a butane fraction which is used in the gasoline blends for vapor pressure control.

Average operating conditions for the poly unit are shown below:

Catalyst Temperatures
- No. 1 bed—Avg. °F—400
- No. 2 bed— " " —405
- No. 3 bed— " " —410

Catalyst tower pressure—450 pounds per square inch

Polymer Production—150 B/D Average

Yield of Polymer
- Volume per cent on topped crude—4.0

Olefin Contents—Mol %

Fresh feed	34
Combined feed	22
Butane and lighter effluent	5

Polymer Inspection

R.V.P. pounds	12.0
A.P.I. gravity, degrees	68.0
A.S.T.M. distillation	
I.B.P.	95
10%	160
50%	230
70%	260
90%	360
E.P.	400
A.S.T.M. gum mgs/100 ml.	1.2
A.S.T.M. octane number	82.5

Officers of the company are M. H. McMurrey, president; A. D. Blackwell, vice-president; A. M. Dulling, vice president and treasurer; O. C. DeLoach, secretary and refining superintendent; F. R. Faris, sales manager; C. M. Bryson, manager of the crude oil purchasing department, and C. T. Blackwell, pipeline superintendent.

Many of the advances in refinery design and operating techniques that have been made since 1931 are exemplified in the McMurrey refinery of today. Originally it was a skimming and visbreaking operation only, with a charge capacity of 12,000 barrels per day of East Texas crude. The products were straight-run gasoline, kerosene and fuel oil. Two years later, a thermal cracking unit, with a design capacity of 1500 barrels per day of gas oil was built.

In 1937 the refinery was completely rebuilt and modernized by Universal engineering and design. At that time a UOP two-coil selective cracking unit was installed, which was able to crack 3750 barrels per day of a wide variety of charging stocks. This cracking unit has been in successful operation ever since. August 15 was the 142nd day of its present run.

The refinery operates on East Texas crude, which is gathered and delivered to the plant by the company's own pipeline system. The products, in addition to gasoline, are naphtha, kerosene, diesel fuel and No. 6 fuel oil. These are marketed chiefly by tank car and transport truck. In order to facilitate the movement of products, the company has installed a loading rack to accommodate 60 tank cars adjacent to the plant. The transport truck dock, where four big trucks can be loaded at the same time, is regarded as one of the most modern in the United States.

The 17-year history of the company is a series of stories of major improvements. These include the latest type of instrumentation, automatic controls and laboratory equipment. One tetraethyl lead blending plant for motor gasoline was installed in 1939, and another for aviation fuel in 1944.

The latest completed chapter is the installation of the poly unit, but other improvements being added are a new crude heater with capacity of 10,000 barrels per day and two new boilers of 250 horsepower each, while consideration is being given to the installation of the latest type catalytic cracking unit.

* Refinery Superintendent, McMurrey Refining Company.

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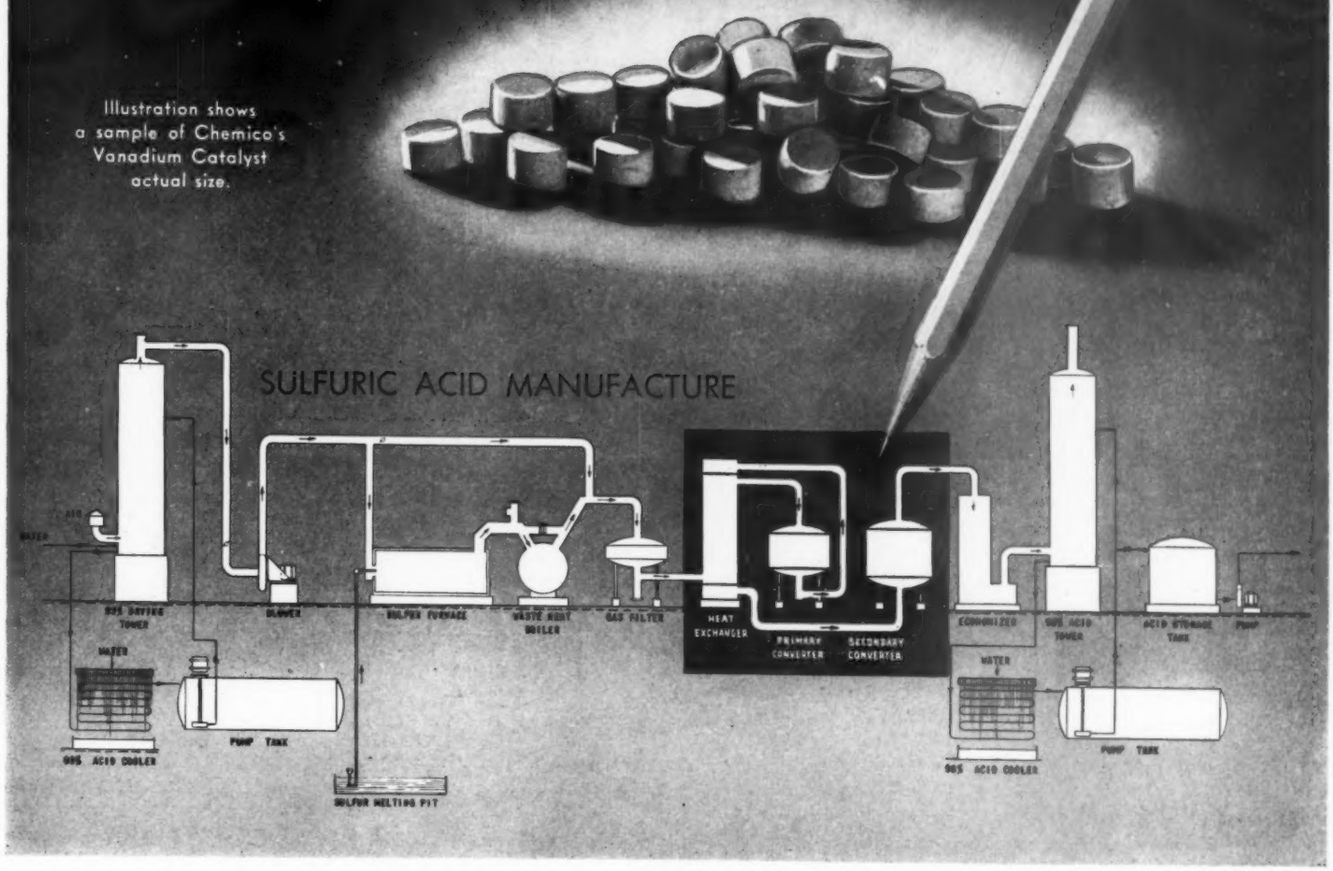

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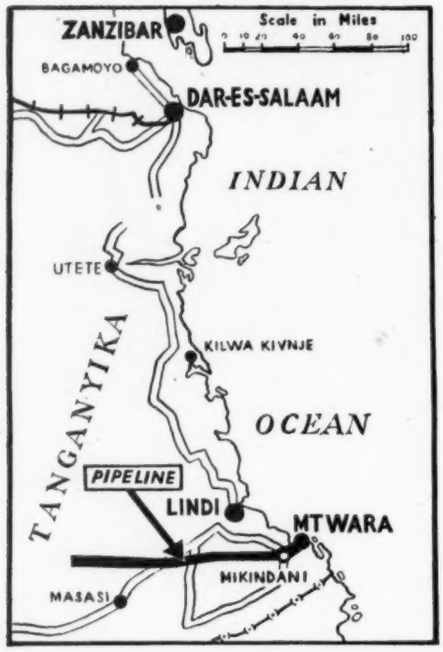
International News and Notes



African Pipe Line

Unusual in purpose and surroundings is the six-inch pipeline which British engineers are laying through jungle and scrub country to enable liquid fuels to be delivered from the East African Coast of Tanganyika inland to the southern area of the British Ground Nuts Scheme.

The pipeline will be 150 miles in length and will cost around $2,000,000. It is expected to be ready for operation early next year. It will run from Mtwara, near Mikindani, on the coast, and will carry an annual volume of between 120,000 and 180,000 tons of gasoline and gas oil to the inland depot. The fuel will be used to feed the mechanical plant used for site clearance—bulldozers, tractors and transport vehicles—as well as the agricultural machinery employed on cultivation.

Shell Petroleum Co. technicians, headed by J. M. Imrie, are supervising the pipeline construction. Mr. Imrie, who has been in Shell's service for 22 years, has had long experience in engineering construction in many part of the world. Already twenty miles of pipe have been laid and four miles welded.

Pipe for use on the line was drawn from surplus military stocks, left in India after the war; the pumping equipment was obtained from the same source. Since the inland terminal is some 1500 feet above the level of the Mikindani port installation, a booster pump station is being installed approximately half way along the line.

Along with construction of the line a port is being built at Mtwara. Meanwhile all equipment is being brought ashore in barges or tank landing craft.

Speaks Before European Chemists

Robert S. Aries, president of R. S. Aries & Associates, recently addressed the Societe de Chimie Industrielle in Paris on the subject of the American petro-chemical industry and its relation to the European chemical industry. He gave another lecture to Federation de Chimie in Brussels, Belgium on the same topic, in which he stressed the tremendous development of petroleum chemicals and predicted that Europe will soon follow the trend. Dr. Aries has just returned from a two-month's tour of Continental Europe and England, where his firm is engaged in the erection of a number of plants.

Exploration Activity in Egypt

An active campaign of exploration to extend the area of existing fields and if possible to locate new sources of supply is planned by Anglo-Egyptian Oilfields Ltd. The future of the company depends upon further discoveries. Sir Robert Waley Cohen, chairman of the board, told the shareholders at the recent annual meeting.

While production from the Ras Gharib field increased last year 320,560 barrels to a total of 8,847,195 the chairman said that this was due partly to installation of dehydrating and desalting facilities and that a gradual decline in the output of existing wells both at Ras Gharib and Hurghada must be regarded as inevitable. One outpost test drilled to the northwest of Hurghada during the past year brought in a productive well pumping 350 barrels daily. A second well in the Asl district, south of Sudr, was completed for 600 barrels daily. The Sudr field is producing about 7,500 barrels daily.

Exploration elsewhere is continuing with a joint seismic survey in the Sinai peninsula and a gravimetric survey offshore in the Gulf of Suez. The chairman reported also that negotiations were in progress with the Egyptian government for the acquisition of land to permit enlargement and modernization of the company's Suez refinery.

Pool Petrol Continued Until Jan. 1

Although the Petroleum Board officially went out of existence on June 30th, some of its works remain and are likely to do so for some time. Typical instance is the decision to retain Pool Petrol (instead of branded individually-marketed petrol) until Jan. 1, 1949. This decision will allow the commercial petrol concerns time in which to organize distribution and publicity again while covering also the current government activity in the field of petrol doping to detect illegal use.

Chemical Plants Reorganized

Plans for reorganization of two British companies, Petrocarbon Ltd., and Petrochemicals Ltd., have been submitted to shareholders and noteholders of the companies. The object is to increase capital for various purposes. One of these is to provide $10,000,000 for completion of the Catarole plant under construction at Partington, near Manchester, and to raise its capacity from 50,000 to 75,000 tons annually. A company known as Styrene Co-Polymers Ltd., has been formed jointly with Lewis Berger & Sons Ltd., to manufacture a paint varnish and a company to be called Oxirane Ltd., will be organized jointly with Lanbro Chemicals Ltd., to produce and market chemicals based on ethylene and propylene derivatives from the Petrochemicals plant. A long term contract has been made with British Paints Ltd., for off-take of the plant's production of indene resins.

J. B. AUG. KESSLER, having reached retiring age, has resigned as a managing director of the Royal Dutch-Shell group of companies. He will continue to act as general managing director of the Royal Dutch Co. and will remain on the boards of De Bataafsche Petroleum Maatschappij, the Anglo-Saxon Petroleum Co., and the Shell Petroleum Co.

Mr. Kessler, who is the second son of the late J. B. Aug. Kessler, the founder of the Royal Dutch Co., entered the service of the associated companies in 1911, after completing his studies at the University of Delft. He served in Romania and subsequently in Russia and returned to The Hague in 1916. At the end of 1919, after having been for a short time acting manager of the Astra Romana company in Bucharest, Mr. Kessler left for England, and became head of the American department of The Anglo-Saxon Petroleum Co., of which company he was appointed a director in 1922. In 1924 he was appointed a managing director of the Royal Dutch and of the B.P.M. and in 1929 a managing director of the "Shell" Transport and Trading Co. His appointment as general managing director of the Royal Dutch was made last year.

The vacancy created by Mr. Kessler's retirement as a managing director of The Anglo-Saxon Petroleum Co. and The Shell Petroleum Co. has been filled by Hendrik Bloemgarten. Mr. Bloemgarten relinquished his appointment as vice-president, exploration and production, of Shell Oil Co., Inc., in New York in December last to become a managing director of the B.P.M. At a general shareholders' meeting of the Royal Dutch Co., held in Amsterdam on June 29, he was elected a managing director of that company also.

L. T. MacNAUGHTON, formerly superintendent of the Imperial Oil Ltd., Ioco refinery in British Columbia, is on special assignment with International Petroleum Co., Ltd., co-ordinating engineering problems.

Mr. MacNaughton graduated from the University of Toronto as a mechanical engineer in 1921 and the following year joined Imperial Oil. In 1929, he was transferred to Colombia as refinery engineer at Barranca Bermeja, becoming superintendent in 1933. In 1937 Mr. MacNaughton returned to Canada as assistant manager at Montreal East refinery and in 1945 was appointed superintendent at Ioco refinery.

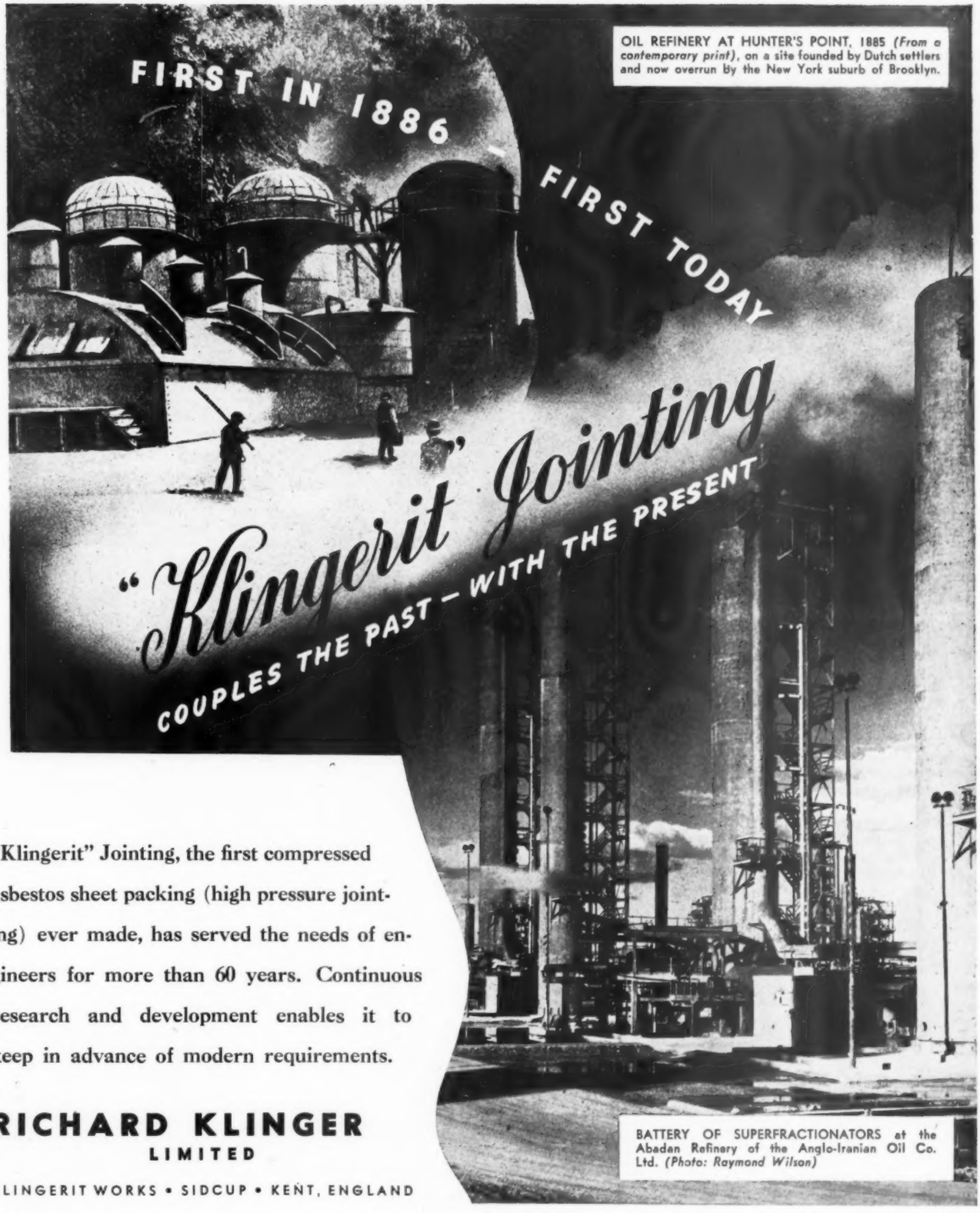
J. J. LYONS has been appointed president of Diadema Argentina S. A. de Petroleo, and will furthermore be responsible for all matters of overall Shell group policy in the Argentine and all matters of joint interest to the various companies operating there. In order to take up these duties, Mr. Lyons is relinquishing his position as general manager of Shell-Mex Argentina Limited, and Mr. J. Roberts has been appointed to succeed him.

In succession to J. L. van Krimpen, who was recently appointed general manager for Shell in Curacao, L. W. Korthals has been appointed general manager of the Diadema, and also vice-president of the local board.

MAJOR KENNETH GORDON, C.B.E., M.D., has been elected to the board of the Central Mining and Investment Corporation Limited of London. He also has been elected to the board and appointed technical director of Trinidad Leaseholds Limited of London.

O. L. MATTHEW, managing director of Industrial Asphalts Co., Ltd., has retired after 41 years in the oil industry. He served in the first world war until invalided out of the army from wounds. After several years with the American department of Anglo-Saxon Petroleum Co. he went to Mexico where he remained until 1929. On his return to London and the formation of Industrial Asphalts he was made managing director.

H. W. MALCOM has retired as secretary of the Shell Transport and Trading Co., London, after 38 years with the group. He joined Shell in 1910 and the next year went to Japan with the Rising Sun Petroleum Co. He was subsequently transferred to the head office at Yokohama in 1922 and was made managing director a year later. He continued in charge there until his return to England in 1935.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"Klingerit" Jointing
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OIL REFINERY AT HUNTER'S POINT, 1885 (From a contemporary print), on a site founded by Dutch settlers and now overrun by the New York suburb of Brooklyn.
BATTERY OF SUPERFRACTIONATORS at the Abadan Refinery of the Anglo-Iranian Oil Co. Ltd. (Photo: Raymond Wilson)

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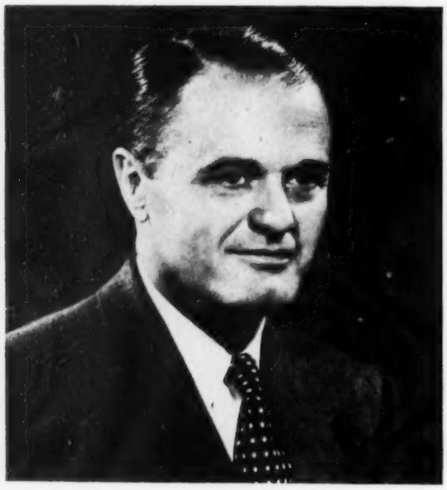
OIL COMPANY STAFF CHANGES



H. G. Swanson

H. G. SWANSON, manager of Shell Oil Company's Chicago marketing division, has been transferred to the company's New York head office as general sales manager for the East-of-Rockies area, P. E. Lakin, marketing vice-president, announced recently. Harry Jacobs, former sales manager, has been named executive assistant to Mr. Lakin. Mr. Swanson joined Shell in 1923 as a bulk depot agent and became division manager in Chicago in 1941. Mr. Jacobs, who has been with the organization since 1910, rose from oil field roustabout in Oklahoma to become sales manager in 1942.

WILLIAM B. PADON has been recalled from Warren Petroleum Corporation's district sales office at Houston, Texas, to assume more responsible duties in the Tulsa sales division headquarters. H. J. Stigletts has been promoted to salesman in the Tulsa headquarters after two years as secretary to Sam I. Hulse, vice president in charge of sales. Mr. Padon rejoined Warren after 44 months in the U. S. Army, 23 of which were spent overseas during which he rose from the rank of private to captain in the Coast Artillery anti-aircraft. Mr. Stigletts also was in the army for three years. He was transferred from Houston to Warren's Tulsa headquarters on Jan, 1, 1947, to become secretary to Mr. Hulse.

T. L. TIERNAN has been named manager of the Sunray Oil Corp. refinery at Allen, Okla. He was formerly assistant superintendent and started with Sunray in 1933 as an electrician. He succeeds Dewey Vinson, who has been transferred to the company's Duncan refinery.

Vice-President F. L. Martin announced the following additional appointments: Ault Milne, former stillman, will be plant superintendent; Luther Jones and Edgar Dean, both former stillmen, will be assistant superintendents; Carl F. Kile, formerly a treater, has been named foreman of treating, blending, and loading racks; Herman C. Kraettli, formerly engine mechanic, has been named mechanical foreman.

JAMES P. MALOTT has been appointed assistant region manager of the Houston region of Continental Oil Co.'s production and drilling department. Edwin A. Austin, formerly district petroleum engineer at Basile, La., has been named to succeed Malott as region petroleum engineer at Houston. Mr. Malott, who went to Houston in 1939 as petroleum engineer, has been with Continental since 1935.

W. F. Bramstedt

W. F. BRAMSTEDT, vice president of California Texas Oil Co. in charge of crude oil marketing has been elected president of Mid-East Crude Sales Co., Ltd., a newly-organized subsidiary of Caltex.

Mid-East will draw its crude oil supplies from the Persian Gulf, particularly Saudi Arabia and Bahrein Island. The New York offices of Mid-East will be at 551 Fifth Avenue. Substantial quantities of crude oil are expected to be available in 1949 to refinery customers of Mid-East, and this new company will continue crude oil supplies to customers in Caltex world markets.

JAMES M. REIDY has been named sales manager of Warren Petroleum Corp. and transferred to Tulsa after serving as manager of the district sales office at Houston, Texas, for the past four years. Fred Creel succeeds Mr. Reidy as manager of the district sales office at Houston. The position of sales manager has been vacant since Sam I. Hulse was named vice president in charge of Warren's natural gasoline sales division several years ago, after ten years of service with the Warren organization. Mr. Reidy was employed in the Warren accounting department in 1938. A year later he was transferred to the sales department. He opened the Gulf Coast district sales office at Houston in 1944.

James M. Reidy

M. P. L. LOVE, director of research at Shell Oil's Wood River, Ill., refinery, has been named research department manager in the company's New York head office. He will coordinate and direct all manufacturing-research programs in the company's East-of Rockies territory.

Mr. Love joined Shell in 1935 as junior chemist at the Wood River refinery. He became chief research chemist at Shell's Houston laboratories in 1942, and research director in 1943. Later in 1943 he was appointed director of the Wood River research laboratories. R. J. Greenshields, chief engineer at the Wood River laboratories, will succeed Mr. Love as research director there.

WALTER L. KEEFE has been appointed manager of the eastern division of Mene Grande Oil Co., C. A., with headquarters at San Tomé. He succeeds Robert L. Boggs, who will assume other duties with the company. Mr. Keefe has been with the Gulf companies for 28 years. He was employed for service in Mexico in 1920 and was transferred to Western Venezuela in 1927. Five years later he was transferred to eastern Venezuela as assistant superintendent of the production department. He was promoted to general superintendent in March, 1937, which position he held until his recent promotion.

DR. HAROLD A. BEATTY has been appointed to the newly-created position of assistant director of research at the Ethyl Corp. research laboratories in Detroit. Dr. Beatty, who has been associated with Ethyl for the past 17 years was technical assistant to the general manager at the laboratories. He has been succeeded in that position by Dr. O. Edward Kurt, who has transferred to Detroit from Baton Rouge, La.

FREDERICK H. MEEDER has been elected vice president of Richfield Oil Corp., of New York, to succeed Marc F. Braeckel, newly elected president. He will continue as manager of Richfield's traffic and product department. Howard G. Meyers, merchandising manager, was appointed assistant to the president. He will be manager of marketing operations. Appointment of Ralph Glock as Richfield's new sales manager was also announced. He has served at various times as district manager of several of Richfield's sales territories including those of lower New York state and Connecticut and the Carolinas.

E. R. BAKER has been appointed manager of Continental Oil Company's newly-created central research laboratories. Mr. Baker comes to Continental from Emery Industries, Inc., of Cincinnati, Ohio, where he was director of development. During the war, he served as assistant chief of the technical division of Chemical Warfare Service.

Fred Creel

A load off their mind

Butterfield Road Tanks ease considerably the responsibilities of Liquid Distributors, who know that a load housed this way is a "load off their mind." Whether it's Petrol or Fuel Oil or Lubricant, there is safe, speedy transport in perfect condition for any and every load carried by Butterfield Road Tanks.

ILLUSTRATED: At top of page: 1,500 Gallon triple compartment Insulated Tank for the transport of Light Oils.
Above: 2000 Gallon Mild Steel Tank for IRAK, for the transport of Spirit.

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FABRICATED IN MILD STEEL, STAINLESS STEEL AND ALUMINIUM

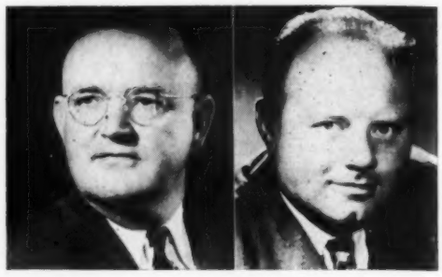
C. G. KIRKBRIDE, director of laboratories for Houdry Process Corp., has been elected vice president in charge of research and development, Brig. Gen. David N. Hauseman, president, announced. Mr. Kirkbride, a director of the company, has served as laboratories chief since April, 1947.

J. DOOYEWAARD, manager of the white products department of Asiastic Petroleum Co. recently retired after 37 years with Shell companies. He joined Asiatic in 1911 and was attached to the benzine general department until 1929 when the white products department was organized under his direction.

W. E. MADDEN will succeed W. M. V. Ash as general manager of the United British Oilfields of Trinidad Ltd., on Nov. 15, when the latter leaves to take up another appointment with the Royal Dutch-Shell organization.

Mr. Madden, who was educated at Rugby, spent three years at the Royal School of Mines. He joined the group in July, 1927, and, after a short period in Romania and The Hague, went to Mexico with "El Aguila" as an Exploitation Engineer. In May, 1938, when he was acting area general manager of the Isthmus Area, he was transferred to the Caribbean Petroleum Co., Venezuela as acting field superintendent at Lagunillas and later became assistant manager, Maracaibo. At the time of his departure from Venezuela last autumn, Mr. Madden was assistant general manager in charge of operations, in Caracas.

CHARLES SCRYMGEOUR, former superintendent of the Montreal refinery of Imperial Oil Ltd., has been appointed superintendent of Ioco refinery in British Columbia succeeding L. T. MacNaughton. Mr. Scrymgeour was born in England and came to Canada in 1914. Joining Imperial at Halifax in 1921 as a junior engineer and draftsman he later became superintendent of the Halifax refinery. He was also concerned with construction for the marketing department in the Maritimes. In 1946, after 25 years at Halifax, Mr. Scrymgeour was transferred to Montreal as superintendent of the refinery.



K. F. Forsyth Vaughan A. Euge

New Emsco Assistant Sales Manager

K. F. Forsyth, manager of California and export sales of Emsco Derrick & Equipment Company, announces the appointment of Vaughn A. Euge to the post of Assistant Manager of California and Export Sales. Mr. Euge has been with Emsco since 1933, starting in the shop and advancing via production control, warehouse, material control and sales order, to his present position. He attended Loyola University, where he graduated with a Bachelor of Science degree, majoring in Commerce and Finance.

Hydra-Line Appoints Key Executives

Blaine Johnston, general manager of the Hydra-Line Division of Johnston Enterprises, announces the affiliation of George W. Sinclair as chief engineer, R. B. (Bob) Luirette as chief of quality control, and Carl H. Engelmohr as sales engineering manager.

Mr. Sinclair worked as engineer for the Reed Roller Bit Co. in the '30's and later as chief engineer and shop superintendent for the Chester T. Allen Core Drilling Co. in Bakersfield. More recently he managed his own firm of consultant engineers, which specialized in the design of large hydraulic machinery. Mr. Luirette was formerly project engineer in charge of International Derrick & Equipment Co.'s mid-continent mobile rig development program. Mr. Engelmohr was, until recently, service manager for the western division of the International Derrick & Equipment Co. He has spent ten years in the oil fields of the Mid-Continent and California areas in sales and sales promotional work.

New Steel Process

Steel now is being made from the liquid phase to semi-finished shape in one simple, relatively inexpensive machine through a joint development of the Republic Steel Corp., and The Babcock & Wilcox Tube Co. Continuous casting of semi-finished steel opens possibilities of simplifying apparatus and increasing the final yield from the original melt. The process eliminates equipment for ingots, soaking pits and the blooming mill.

Completes Ethanol Plant

Shell Chemical Corp. has completed its plant at Houston, Texas, for the manufacture of synthetic ethanol. The process depends on the direct hydration of ethylene from refinery gases. The product will be offered as a proprietary solvent under the trademarked name of "Neosol" and in standard specially denatured grades.

Globe to Install Fluid Cat Cracker

The Globe Oil & Refining Company has recently entered into an agreement with Universal Oil Products Co. for the installation of a fluid catalytic cracking unit at Globe's Lemont, Illinois, refinery. Utilizing existing feed preparation equipment, the cat cracker will handle 6,000 barrels of heavy vacuum gas oil per stream day at 50 percent conversion level.

REFINERY VESSELS

• BUBBLE TOWERS • DRUMS
• PRESSURE VESSELS • STORAGE
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An Extra Measure of Quality — All Around QUALITY Found in Material, Design and Craftsmanship of the Finished Fabrication That Rolls From the McNamar Plant, Continues to Bring Forth Expressions of Satisfaction and Appreciation From Men Who Know McNamar Vessels. In Refining Operations, You will Find Hundreds of McNamar Pressure Vessels Serving Efficiently After Many, Many Years of Steady Use.

McNamar's NEW BUBBLE CAP
PREVENTS SLOT CLOGGING
PROVIDES AN EVEN DISTRIBUTION OF GAS!

NEW SERRATED BUBBLE-CAP

THIS NEW, SERRATED BUBBLE CAP WAS SHOWN IN OPERATION INSIDE A MINIATURE TOWER AT THE RECENT WORLD OIL SHOW IN TULSA. McNAMAR'S EXCLUSIVE SERRATED BUBBLE-CAP COMPLETELY ELIMINATES CLOGGING OR STOPPING-UP OF THE SLOTS, A PROBLEM THAT OCCURS SO OFTEN WITH CONVENTIONAL-TYPE BUBBLE CAPS, DURING THE OPERATION OF THE TOWER. GAS IN DISTRIBUTED BELOW THE SURFACE OF LIQUID AND IS FORCED DOWNWARD, THUS HOLDING THE GASES IN THE LIQUID. THIS ELIMINATES ANY POSSIBILITY OF CHANNELING. THROUGH AN EVEN DISTRIBUTION, PLUS AGITATION, A MAXIMUM CONTACT, OR BLEND, IS ASSURED.

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New Colombian Field in Operation

Formal recognition of the entry into commercial operation of Shell's Dificil field in Colombia took place on Aug. 26 with the start of pipe line shipments. Initiation of the oil flow took place in the presence of a group of Shell officials and representatives of the Colombian government.

Oil from Dificil moves through a line 87 kilometers in length connecting with the Andian Pipe Line at Plato and thence to the Andian's terminal near Cartagena. The line has a capacity of 7,000 barrels daily but at present is moving about 3000 barrels per day. Dificil is the ninth producing field developed in Colombia and the second of the Royal Dutch-Shell Group.

Organizes Marine Research Department

Anglo-Saxon Petroleum Co., Ltd., a member of the Royal Dutch-Shell Group, has organized a department of marine research and development. John Lamb, widely known marine engineer who has been manager of the technical division of the company's marine department, has been made director of the research department. Other appointments resulting from this change include the following: A. Logan becomes manager of the technical division; W. J. Brown replaces Mr. Logan as chief of the repair and maintenance section; Capt. H. B. Russell is appointed a joint manager of the shipping division, and Capt. D. Williams becomes acting head of marine staff and crew sections.

Visits Latin America

D. T. O'Connor, export sales representative of Shaffer Tool Works and Telematic Corp., left on September 2 for Venezuela, Colombia, Ecuador, Peru and Trinidad, where he will visit all of the principal oil field operations.

R. S. Blazer

R. S. BLAZER has been elected president of Allied Oil Company, Inc., Cleveland, Ohio. Mr. Blazer was graduated from the University of Illinois in 1928, was hired by Allied Oil in September of that year on his 21st birthday. For the past 10 years he has been a director of Allied and vice president in charge of marketing. He is a charter member and past president of the Cleveland Petroleum Club.

M. L. HAIDER was elected a director of Imperial Oil Limited at the recent annual meeting. Mr. Haider is manager of Imperial's producing department. His career in the oil industry began a few months after he graduated from Stanford University when he became a research engineer in the natural gas field. He became a chief engineer and in 1938 moved to New York as head of the production research and engineering department of the Standard Oil Development Co. He remained in this position until 1945 when he was appointed executive assistant in the producing department of Standard Oil Company (N. J.) He joined Imperial Oil as manager of the producing department in 1946.

E. KEITH LEWIS has been appointed superintendent of the Montreal East Refinery of Imperial Oil, Ltd. Mr. Lewis, a Nova Scotian, began his career with Imperial in 1933 as an industrial engineer at Halifax refinery. In 1942 he was transferred to Sarnia as process refinery foreman. In October of the same year he joined St. Clair Processing Corp., as one of the specialists needed for the Canadian production of synthetic rubber. After the St. Clair comwas merged with Polymer Corporation he remained for a time as production manager but returned to imperial Oil at Sarnia late in 1946. He was appointed supervisor of the production control group of the engineering and development division in June 1947.

CLIFF W. PEERY has been appointed general superintendent, production department, eastern division of Mene Grande Oil Co., succeeding Walter L. Keefe. Mr. Peery started with Mene Grande as a junior geologist in 1934. He was subsequently petroleum engineer, chief petroleum engineer and assistant superintendent, production department. During World War II Mr. Peery served in the U. S. Marine Corps for three years.

FRANK PICKELL, manager of industrial relations for Stanolind Oil and Gas Co., has been named advisor in industrial relations for the company. Robert S. Newhouse succeeds him as manager of the company's industrial relations department.

The quality of finish on Unbrako screws is unsurpassed anywhere in the world. Each screw is inspected, and every batch is representatively tested to withstand approximately 90 tons per square inch in tension.

La calidad del acabado en los tornillos "Unbrako" no es superada en parte alguna del mundo. Cada uno es examinado y cada tanda es comprobada representativamente para que cada pieza tenga una resistencia tensil de 90 toneladas por pulgada cuadrada.

Manufactured by the

UNBRAKO SOCKET SCREW Co., Ltd., Burnaby Road, Coventry

Fuel Supply Outlook Reassuring to Consumers

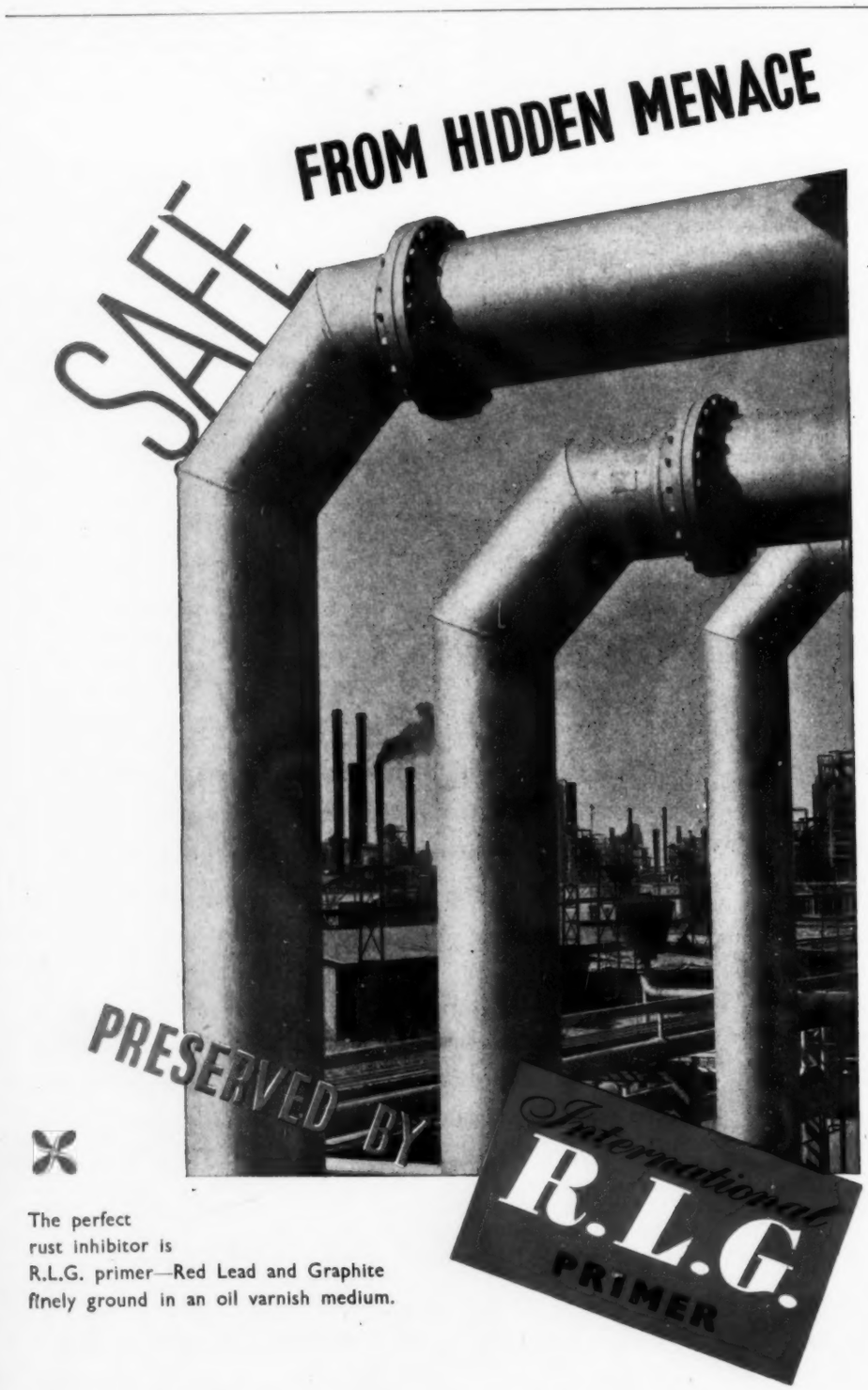
(Continued from page 43)

There is far less flexibility in the case of kerosene with the result that both refiners and distributors are somewhat apprehensive about meeting all demands which may be made on them this coming winter. Space heaters which burn kerosene or No. 1 fuel oil generally are sold by hardware stores or other establishments which do not sell fuel. Little or no restraint has been put on sales of appliances as has been the case with central heating plants. So the oil industry does not have much reliable information on which to base a guess about next winter's demand. Last winter it was kerosene, actually, rather than fuel oil, which created the biggest headlines. In New York and other large cities the cold-water flats which are heated wtih kerosene have reserve storage generally of only a five-gallon can. With only that much oil in the house, it is not surprising that even a brief interruption in supply caused trouble. The home owners with central heating plants and 275 to 1,000 gallons of storage capacity had little or no trouble. Usage of kerosene fractions for fueling jet planes, while not yet a large factor in point of volume, hasn't improved the supply situation on this product.

Refinery yields of kerosene averaged between five and six percent in the decade before World War II. In 1946 average yield was 6.03 percent; in 1947 it averaged 5.96 percent, and in the first half of 1948 the average was 6.28 percent. Since little kerosene is produced synthetically by cracking, the majority being obtained by straight distillation, it is clear that the industry is limited largely in its output by the character of crude oil available for processing. If shortages develop, there isn't much that can be done about it.

A number of industrial leaders in recent months have peered into the future and have sought to indicate what the growth in dieselization of railroads, motor trucks and industry and growth in oil burners will mean. Robert B. McColl, president of American Locomotive Co., is currently quoted as saying that his company will build $1.25 billions in diesel locomotives in the next ten years. He estimated that 20,000 diesel locomotives will be needed to replace 35,000 steam locomotives, some 7,000 of which are oil burners now; the latter burn far greater quantities of oil in boilers than they would in diesels.

R. J. S. Pigott of Gulf Research & Development Co. told the National Petroleum Association that United States railroads now consume eight percent of the country's oil supply and with complete dieselization would consume 44 percent of all the oil. As is the case with kerosene, dieselization has got to stop somewhere. But for the coming winter, the outlook for adequate supplies of all principal oil products is distinctly encouraging.



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rust inhibitor is
R.L.G. primer—Red Lead and Graphite
finely ground in an oil varnish medium.

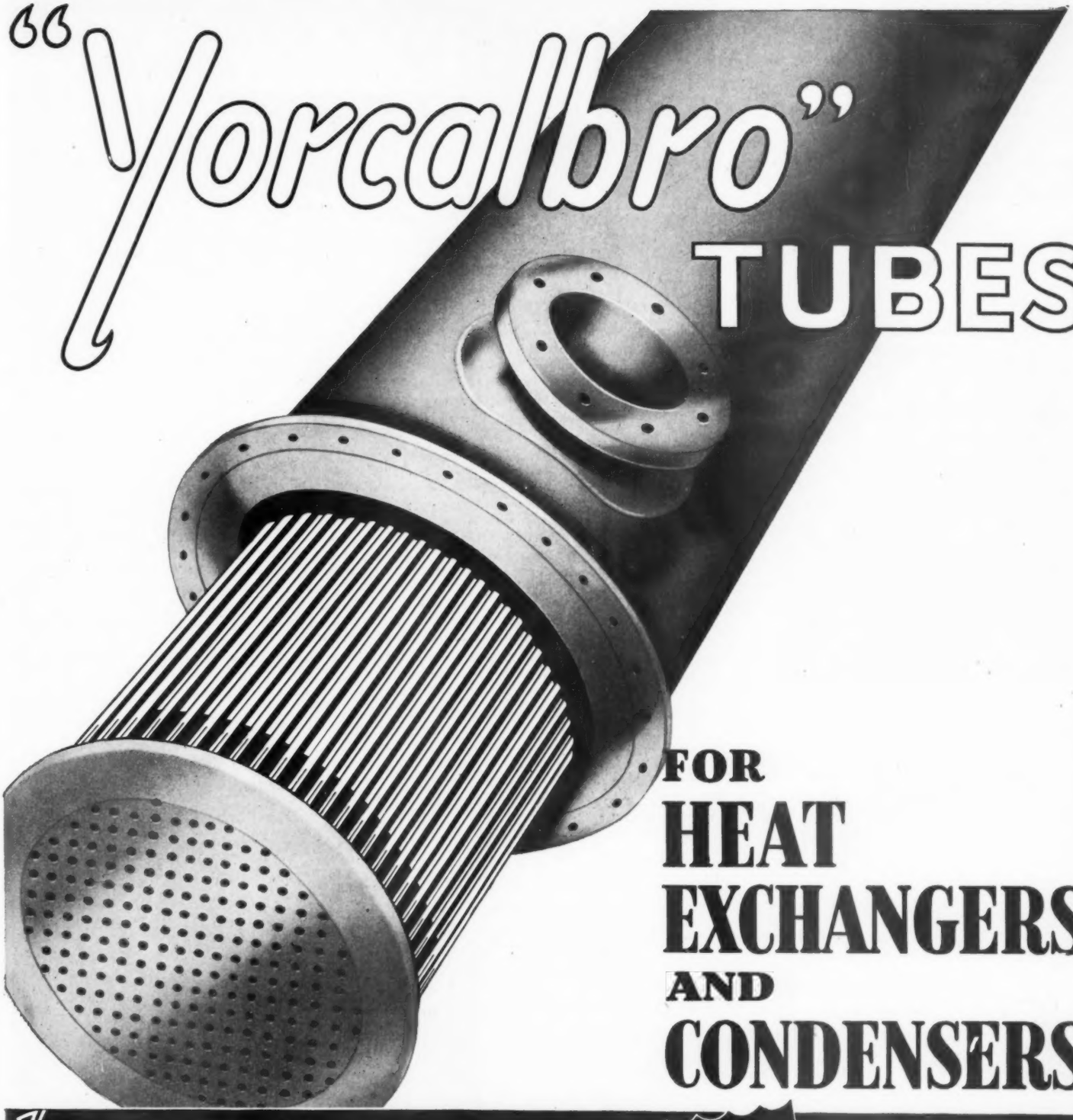
To Distribute Page Tools

Wm. C. Kinder, vice president and manager of the D/B division of the Emsco Derrick & Equipment Company, is here shown signing a contract with John S. Page, inventor of the Page tension type production equipment and president of the Page Oil Tools, Inc., wherein the D/B division of Emsco acquired the exclusive distribution of Page oil tools in all fields of the United States with the exception of the Pacific Coast states. The Page equipment will be stocked in D/B stores and Continental Supply Co. stores.

Appoints Export Manager

Farrell-Birmingham Company, Inc., has appointed Carl F. ter Weele as export manager. He will make his headquarters at the company's New York office, 3700 Chrysler Building. Mr. ter Weele received his education in Europe. His first business association was in the Dutch East Indies. After his reutrn to Europe from the Far East, he engaged in the export trade.

"Yorcalbro" TUBES



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EXCHANGERS
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"Yorkshire" TUBES
IN COPPER, BRASS, CUPRO-NICKEL
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CONDENSER TUBES
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LEEDS
ENGLAND

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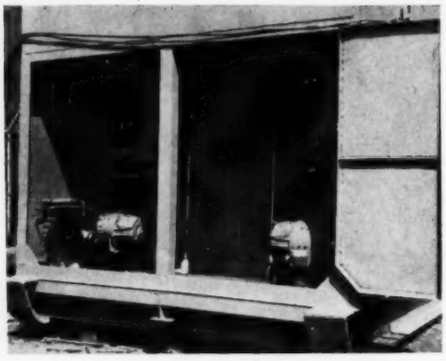
Christen Joins Barnes Company

George H. Christen recently joined the staff of the W. M. Barnes Co., Los Angeles engineers and contractors, as sales engineer. Mr. Christen has been associated with the petroleum and gas industries for the past 21 years, having joined Westcott & Greis, Inc., early in 1927. Later he became manager of the Los Angeles works of American Meter Co. He resigned from that company early in 1936 to accept a position as Pacific Coast manager for the Crosby Steam Gage & Valve Company. At that time a factory branch office and warehouse was opened in Los Angeles under Mr. Christen's supervision. He continued there until he resigned to accept his present position with the W. M. Barnes Company, where he will handle sales promotion.



Portable Refrigeration Reefers

Frozen food for oil construction and exploration crews in the Middle East will be transported in portable cargo reefers recently designed by Refrigeration Engineering Corp., Philadelphia. A group of reefers now is under construction to enable a steady flow of frozen food to be shipped on the decks of tankers or cargo ships.

Each reefer has a capacity of 1,100 cubic feet and will handle from 20 to 30 tons of food per trip. Refrigeration machinery is self-contained and is capable of maintaining the stored food at zero in ambient temperatures up to 120°F. Units are air-cooled and use Freon-12 as refrigerant. A stand-by unit is enclosed in each reefer to provide for a possible interruption of compressor action.

With the portable reefers mounted on skids, it is possible to drop off loaded units at destination and exchange them for empty units. Contents may be unloaded into permanent refrigerated storage or the unit can be connected to on-shore refrigerating machinery by snap-on fittings.

Venezuelan Production

Production of crude oil in Venezuela during the month of July amounted to 41,814,541 barrels, an average of 1,348,856 barrels daily. As compared with June, this daily average is higher by 10,616 barrels. Exports for the month were 37,305,355 barrels. Production by companies is shown in the following table:

Company	West	East	Total
Creole	15,164,389	4,950,218	20,114,607
Mene Grande	1,841,853	4,853,037	6,694,890
Shell	12,847,224	—	12,847,224
Sinclair	—	587,393	587,393
Socony	—	946,515	946,515
Texas	—	265,243	265,243
S. A. P. Las Mercedes	—	272,586	272,586
B. C. O.	31,621	—	31,621
Orinoco	8,718	—	3,718
Phillips	—	42,963	42,963
Rexco	—	—	—
Atlantic	—	2,781	2,781
Total Bbls.	29,893,805	11,920,736	41,814,541

Lack of Steel for Tankers Criticized

Criticism of the British Government's refusal to allow maximum steel for tanker construction was made by Charles D. Rigg, steel export, speaking in Glasgow recently. The shipbuilding industry is receiving authority for only two-thirds of its steel requirements from the Steel Control, although it has contracts on hand representing three years' work at full capacity, he said. Britain's merchant fleet is in sore need of vessels, especially tankers, but 35 percent of shipbuilders' contracts are for foreign owners.

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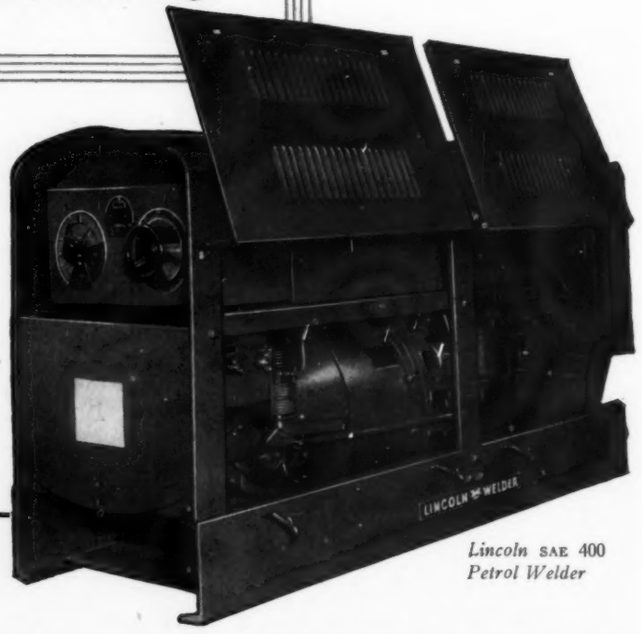

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The spirit that quickeneth

WE CELEBRATE OIL PROGRESS DAY on October 14th. It is an old American custom on such occasions to point with pride to humble beginnings, present bigness, and the promise of the future.

Since Edwin L. Drake, onetime railroad conductor, in spite of popular ridicule, sank his well in 1859, petroleum has developed into one of the top industries of America. Its working plant is valued at 30 billions of dollars. This plant produces nearly two-thirds of all the world's oil. From its refineries, in constant stream, comes the gasoline that powers the Motor Age. According to government figures, the industry directly and indirectly provides employment for five million men and women.

Thus the case for celebration could rest on size alone. There is also abundant reason to view with enthusiasm the industry's future. Already from its laboratories have come 11,000 by-products from the drop of oil. These useful by-products range from acids to asphalt, from ink to insecticides, from vitamins to velvets, from brushes to building material, from fertilizers to freezing compounds, from resin to rayon, from cocktails to cosmetics. The list grows every day. Whole new industries will spring from this drop of oil. Millions unborn will earn their livelihoods from its magic. For everyone, the luxuries of today will become conveniences, and indeed, necessities, because of these new products from petroleum.

The oil industry, however, has another asset greater than machinery and plants and capital and laboratories. The amazing development of the industry did not come about by accident. It has grown great and serviceable—and will continue to grow — only through the devoted and sacrificial attention and enthusiasms of men and women—of human beings.

The greatest mistake we can make is to act upon the false premise that business is self-starting, is cut and dried routine. Economists boast of our eighty million horsepower on call in our manufacturing plants. Statisticians classify this horsepower as "prime movers," tremendous energy at the turn of a switch or the pull of a throttle. How fantastic! The real "prime-movers" of an expanding economy are men—men of spirit and the capacity to do. It is they alone who sustain the pressure of progress. The spirit of the millions of men and women who are eager to get on and up in the world is the most powerful factor in our business life. We, the people, in our own enlightened self-interest, should see to it that this spirit is not deadened—in petroleum or any other industry—by popular indictments, unwise restrictions, excessive taxation that absorbs risk capital, competition by one's own government.

As the nation celebrates the progressiveness of the oil industry this month, it might well re-dedicate itself to the proposition that America progresses, is kept a going concern, through the spirit and enthusiasm of its business men and women. They are the nation's indispensable resource, the real ambassadors of the more abundant life.

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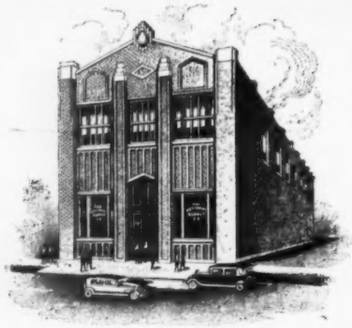

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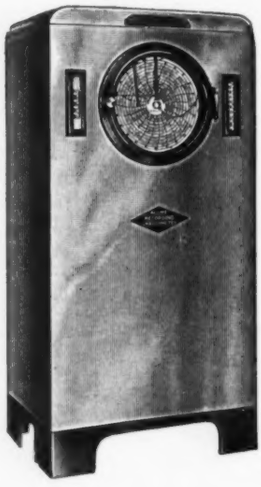

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Motor Gasoline from Middle East Crude

(Continued from page 55)

removing up to 50% of the sulphur content, but the losses would be excessive.

The research/motor octane appreciation is extremely good and samples have shown appreciations up to 16 numbers. The sulphur content of catalytic gasolines from Iranian wax distillate is located mainly at the back end of the distillation range. However, the heavier ends have very good octane numbers and it is, therefore, desirable to run to the full end point (400°F.), especially as there is no fear of contamination from feedstock light ends. The volatility tends to be high, but, with a full range product not much anxiety is felt on this score. Nevertheless, for purposes of correlation the limit has been maintained at 28% volume at 158°F.

The most important cases are probably those where maximum catalytic cracking capacity is installed, and either maximum yield of total gasoline is required or maximum octane numbers are of interest. The yields and properties of such gasoline are presented in Table 8.

The appreciable increase in octane number obtained by catalytic disulphurization compared with sweetening is again in evidence.

Where all the S. R. gasoline is available and catalytic cracking is installed to augment yield, but the final octane numbers do not reach the required standard, the inclusion of some naphtha up-grading process will be necessary. The several variations of such processes are: Reforming and Sweetening, Catalytic Cracking and Polymerization; Reforming and Catalytic Desulphurization, Catalytic Cracking and Polymerization; Hydroforming and Catalytic Desulphurization, Catalytic Cracking Polymerization.

As may be expected, the inclusion of catalytic gasoline has the most marked effect on the reforming and sweetening case. Substitution of catalytic desulphurization for sweeting of S. R. gasoline in the reforming case has most effect in the lower octane ranges. An important point to note in the hydroforming case is that the leaded octane numbers are very little changed at the higher levels. Calculated yields and properties of the highest octane number gasolines produced by these combinations are given in Table 9.

Table 9

Motor Gasolines of Highest Octane Number Produced by Blending Catalytic Cracked Gasoline, S. R. Gasoline and Reformed or Hydroformed Naphtha

PROCESSES	Sweetening S.R. Gasoline Naphtha Reforming. Max. Cat. Cracking (25% Crude) Cat. Poly.	Cat. Desulph. S.R. Gasoline Naphtha Reforming. Max. Cat. Cracking (25% Crude) Cat. Poly.	Cat. Desulph. S.R. Gasoline Naphtha Hydroforming Max. Cat. Cracking (25% Crude) Cat. Poly.
Composition (% vol.)			
S. R. Gasoline	11.5	11.4	10.6
Reformed or Hydroformed Gasoline	10.2	10.2	13.3
Catalytic Gasoline	9.5	9.5	9.5
Catalytic Polymer	2.8	2.8	1.8
Total Yield (% volume on crude)	34.0	33.9	35.2
Properties			
S. G. @ 60°F.	0.7225	0.7225	0.736
Gravity °A. P. I.	64.4	64.4	60.8
A. S. T. M. Distillation	°F. °C.	°F. °C.	°F. °C.
10% vol.	126 = 52	126 = 52	126 = 52
50% vol.	204 = 96	204 = 96	208 = 96
90% vol.	336 = 168	336 = 168	344 = 173
F. B. P.	400 = 204	400 = 204	400 = 204
R. V. P. lbs.	10	10	10
Sulphur % wt.	0.09	0.06	0.05
Octane Number (Motor)	74.3	75.5	77.2
" + 1.25 mls. TEL/USG.	80.5	81.8	84.3
" + 3.0 mls. TEL/USG.	83.5	84.9	87.8
Octane Number (Research)	81.6	82.8	84.2
" + 1.25 mls. TEL/USG.	87.8	89.1	91.3
" + 3.0 mls. TEL/USG.	90.8	92.2	94.8
Research/Motor Appreciation	7.3	7.3	7.0

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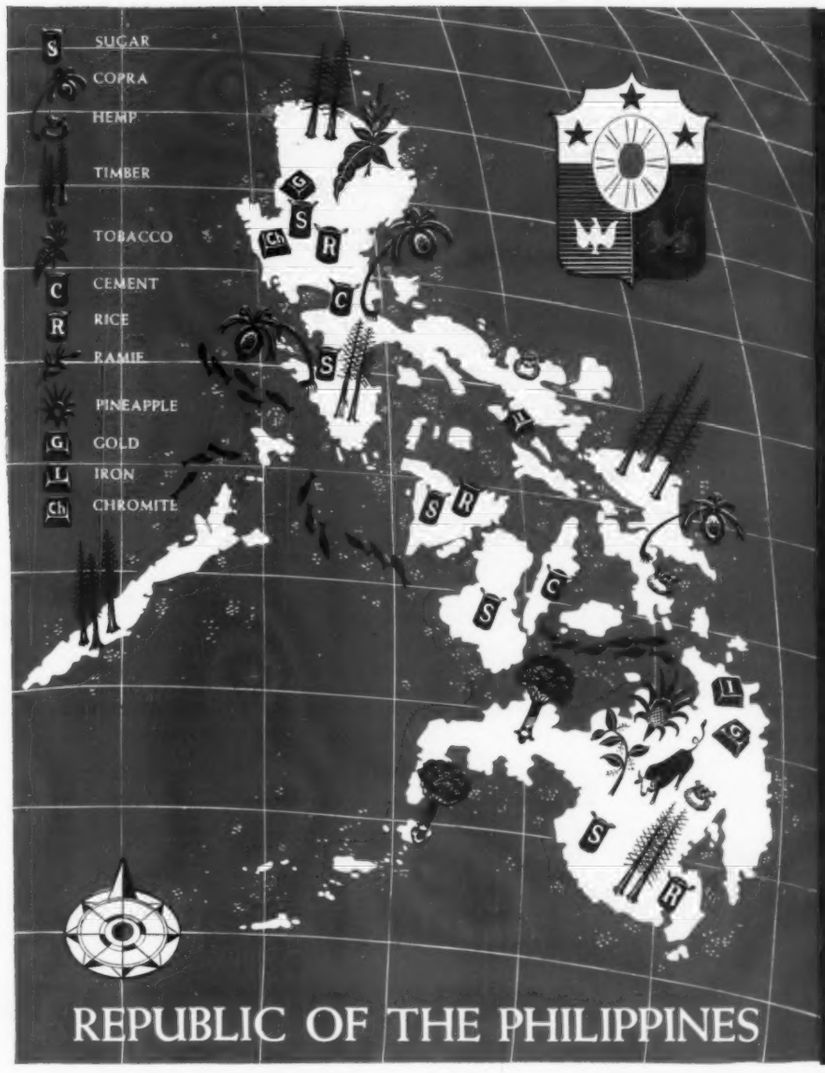

VISITORS to the Philippines see a land of rare beauty . . . tumbling waterfalls, quiet lakes, wide valleys, smoke-tipped volcanoes, sunny coastal plains and the breath-taking scenery around Baguio.

But even more inspiring is the sight of a free people busily building their new nation . . . 19 million of them spread over the 115,000 square miles which make up the land area of the 7,083 islands of the Philippines. If the indomitable spirit and courage displayed by the Philippines people in withstanding the ravages of war are any indication, this new Republic is destined for a long and successful future.

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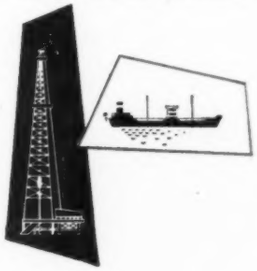

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Trinidad Leaseholds Promotions

J. B. Christian has been promoted to assistant general manager of Trinidad Leaseholds, Ltd., Trinidad, B.W.I. and H. W. Macnaughton-Jones has been appointed manager of the refinery division of the company.

To Modernize Cat Cracker

An engineering and construction contract covering the modernization of the Ashland Oil and Refining Company's Houdry T.C.C. catalytic cracking unit has been awarded to Catalytic Construction Co.

Salient changes to the kiln include conversion to solid bed design and a new catalyst distributing system. Changes include increased kiln carbon burning capacity by the addition of two zones to the existing eight. Revisions in the piping and instrumentation will also be made.

New Book

The Alkylation of Alkanes; by Gustav Egloff and George Hulla; published 1948 by Reinhold Publishing Corp., New York; 1138 pages; $20.00.

During World War II the petroleum refining industry was, and still is, highly interested in the alkylation of alkanes, because this reaction is a basic process for producing high-octane gasoline. Over 800 patents have been issued on various forms of this reaction, and these patents incidentally contain a great store of general information on organic chemistry that is useful in research on petroleum refining. The authors here present these documents in great detail; many are reproduced in full, but all are given enough attention to show what the inventors aimed to accomplish.

The indefatigable Egloff and his associates have still further intentions about the subject. During the late war a number of oil companies pooled the information on alkylation that they had acquired the hard way. This information remained secret during the war but has now been declassified. The authors are digesting this accumulated knowledge and are at work on two more volumes about alkylation.

The present Vol. I classifies the patented processes according to the catalyst used. Then follows thermal alkylation of alkanes and subsidiary operations of the prior formation of iso-alkanes and alkanes, and the steps of defluorination, isomerization, polymerization, hydrogenation, dehydrogenation, cyclization and reforming. Miscellaneous processes involving various reactants and a chapter on demethylation conclude the work, which is too vast for this reviewer to attempt to describe in detail. It is a valuable reference book.

Oil-Shale Reserve Drilling

Boyles Bros. Drilling Co., of Salt Lake City, Utah, has been awarded a contract for exploratory drilling on the U. S. Naval oil-shale reserves in Western Colorado. Seven diamond core drill holes ranging in depth from 570 to 1,200 feet will be completed within 15 months. The contract is a part of a coordinated industry-government program. Union Oil Co., of Calif. and the Pacific Co., a subsidiary of the Standard Oil Co., of Calif., have disclosed plans for prospecting their neighboring properties.

Cooper-Bessemer Booklet

Cooper-Bessemer Corp., Mount Vernon, Ohio, and Grove City, Pa., has published a booklet in which the company's complete line of products is listed and described in brief form. In addition to illustrations of the various engines and compressors, the booklet shows the type and designation, range of sizes, a brief description of design and construction and main applications recommended. Copies of the folder are available on request to the company headquarters at Mount Vernon.

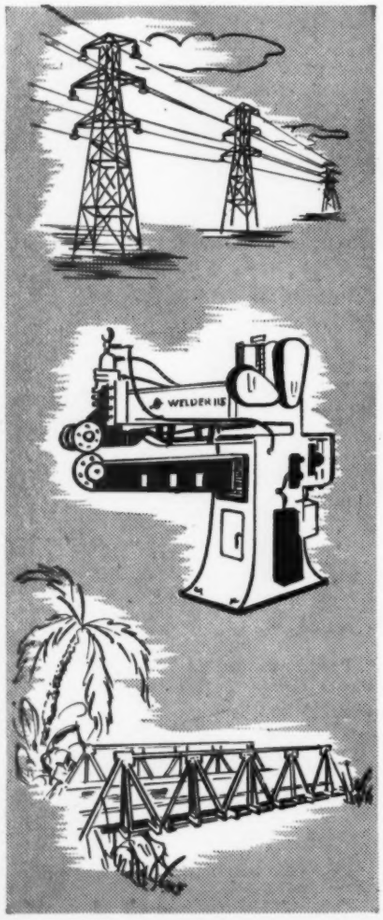
Oil to Control the Tsetse Fly

Oil will be employed by the British government to control the spread of insects which make extensive colonial areas uninhabitable. At the invitation of the insecticides committee of the Colonial office, L. W. Leyland Cole, chief agricultural chemist for Shell Petroleum Co. left London recently for East Africa. He will visit Kenya, Uganda, Tanganyika and the Sudan to study at first hand the problem of devising new means for combatting tsetse flies, mosquitoes and other insects which have long prevented the cultivation of large tracts of these territories.

No. 1 enemy on the list is the tsetse fly which is a carrier of diseases fatal alike to humans and to animals. Many regions are virtually uninhabitable owing to the presence of these insects. Mr. Cole's plans include the use of fixed-wing and helicopter aircraft for "fog-spraying" infested areas with oil-base solutions and synthetic chemicals.

To Manufacture Coatings

Lion Oil Company will enter the field of protective coatings by building a new $250,000 plant which will be completed in December. Ray David Cunningham has been appointed sales manager of the protective coatings department. Plans are to produce government-approved rust-preventive compounds and industrial rust preventives. One section of the new plant will be devoted to the solvent type, oil type and grease type rust preventives, and a second section to mastic type coatings.



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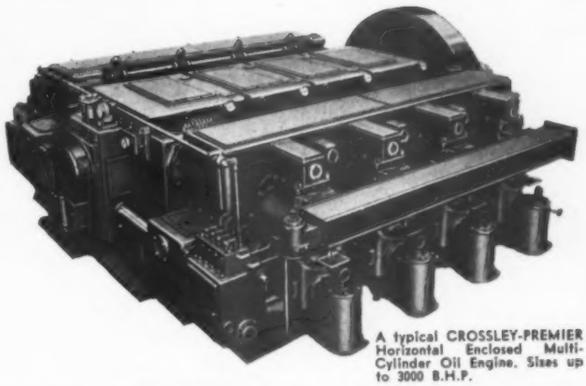

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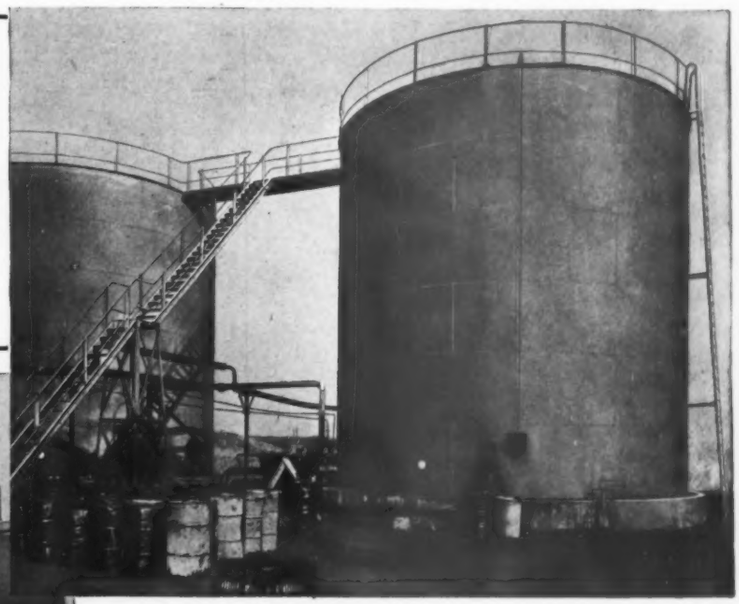

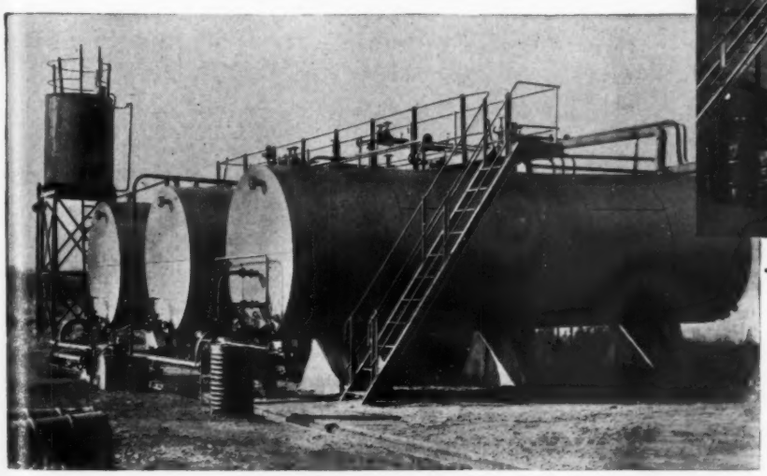

Oxley built installations at Ellesmere Port, Cheshire. Above: Close up of two 30 ft. diameter 30 ft. deep storage tanks. Left: Three 9 ft. diameter x 30 ft. long single compartment storage tanks with connecting platforms and access staircase.

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Manufactures Titanium

The DuPont Company recently announced that it had begun the small-scale manufacture of titanium metal. A pilot unit of 100 pounds daily capacity has been successfully placed in operation at the Newport, Del., plant. Current price is $5 per pound, but this is expected to be reduced as production increases.

Yield strength of titanium in annealed form is about 70,000 pounds per square inch; in cold worked form, about 100,000 pounds. Ultimate tensile strength is 80,000 pounds per square inch annealed and 110,000 pounds cold worked. It has excellent resistance to corrosion. What will happen when various titanium alloys are worked out is a matter of conjecture, but it is thought that metal properties superior to anything now known will be developed.

Improved Catalytic Process Announced

An improved catalytic cracking process features Sun Oil Company's plans for a $16 million expansion program at its Toledo, Ohio, refinery. The process, known as Houdriflow, was developed jointly by Houdry Process Corp. and Sun. It employs a pneumatic lift for circulating the catalyst. All of the catalytic elements, such as the reactor and kiln, are of such size that they can be fully assembled in the shop and shipped to the site by rail with consequent saving in erection time and cost. Sun's new unit is designed to charge 42,000 barrels a day of oil to the reactors with a high proportion of heavy liquid feed.

Also scheduled for construction at the Toledo refinery are a large gas recovery and gasoline stabilization plant, a new polymerization plant, a crude distillation unit, a vacuum flash unit and auxiliary units and equipment required by the major installations. These include a steam generating unit, a water supply and cooling unit, charge and product tankage, storage facilities, a warehouse, maintenance shops, an electric sub-station and office facilities for operating personnel.

Catalytic Construction Co., a subsidiary of the Houdry Process Corp., will handle purchasing, expediting and field construction. Process design for the gas compression unit will be done by Fluor Corp. Process Engineers, Inc., will design the gas absorption and gasoline stabilization unit. Major construction is expected to be completed by Dec. 31, 1949.

Governors of four oil states at the recent New York meeting of the Interstate Oil Compact Commission. Left to right: Gov. Beauford H. Jester of Texas, chairman of the commission; Gov. James H. Duff of Pennsylvania; Gov. Roy J. Turner of Oklahoma; and Gov. Millard F. Caldwell of Florida. The four governors attended a luncheon for the press during the meeting of the commission at which New York newspaper writers were given a historical sketch of the development of the commission and the causes which led up to its organization. J. C. Chatfield, managing editor of WORLD PETROLEUM, was moderator of the press luncheon panel. Speakers included Gov. Jester; Claude Barrow of the Daily Oklahoman; Ken Sclater of the Petroleum Engineer and John Harper of Harper Oil Co.

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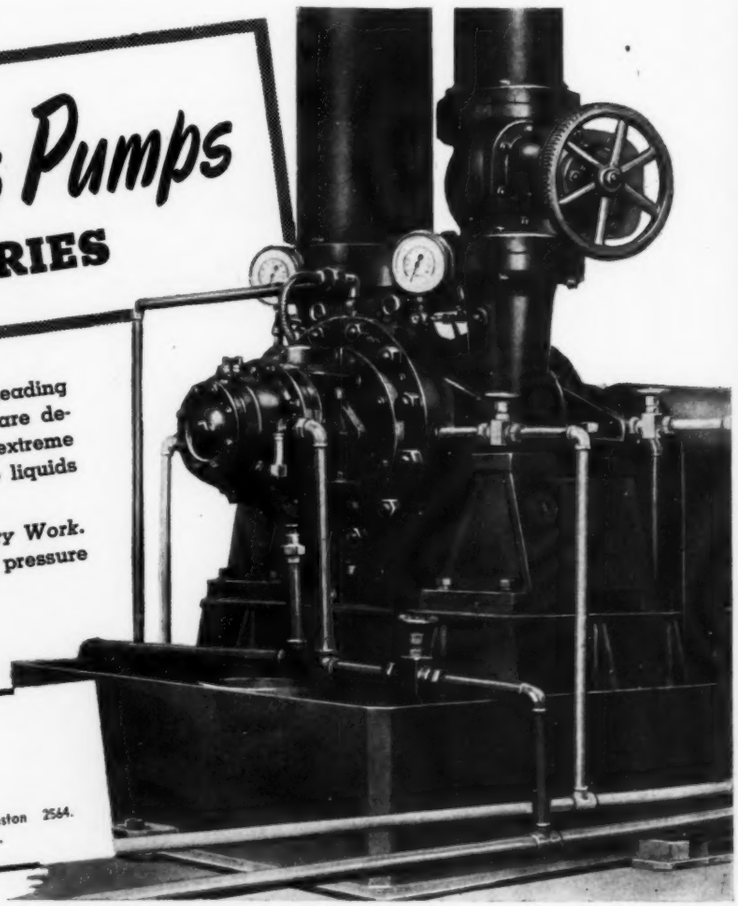

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